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June 6, 1966

JOHN F. KENNEDY SPACE CENTER

PROJECT DEVELOPMENT PLAN

FOR

LAUNCH INSTRUMENTATION

DIRECTOR
INFORMATION SYSTEMS

LAUNCH INSTRUMENTATION
PROJECT DEVELOPMENT PLAN

R&D Funding Code 955

This document is an official release of Manned Space Flight and its requirements shall be implemented by all cognizant elements of the Manned Space Flight program.

The effective date of this document is November 10, 1964

Approved

George E. Mueller

GEORGE E. MUELLER
Associate Administrator
for Manned Space Flight

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This document has been prepared in accordance with the requirements of NASA General Management Instruction 4-1-1, and OMSF Instruction MP 9320.044.

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Manager, Apollo Program

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REVISION LOG

Changes to the original Project Development Plan for Launch Instrumentation, dated September 25, 1964, involved more than a 60-percent rewrite. Future revisions to this June 6, 1966 edition will be noted on a revision log.

FOREWORD

This development plan describes the launch instrumentation systems being developed and implemented for KSC by the KSC Director, Information Systems. The instrumentation on board the flight vehicle and checkout equipment related directly thereto are not a part of launch instrumentation.

The specific instrumentation systems and services provided by this organization for the Ground Operational Support System (GOSS) are described briefly and illustrated with block diagrams. History, current status, and plans for the systems are briefly stated. A cross-reference to the systems is provided by discussing the instrumentation facilities. Systems milestones, manpower, and funding schedules in the official OMSF format are included.

CONTENTS

DEFINITIONS

ADP	Automatic Data Processing
ALDS	Apollo Launch Data System
AFETR	Air Force Eastern Test Range
AO	Administrative Operations
CIF	Central Instrumentation Facility
CKAFS	Cape Kennedy Air Force Station
CSM	Command Service Module
CW	Continuous Wave
DRS	Digital Recording System
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
E&L	Engineering and Laboratory Building at Area 42 on Cape Kennedy
FCA	Frequency Control Analysis Building
FM	Frequency Modulation
Far Field	The area more than 1500 feet from a launch pad
GHz	Gigahertz
GOSS	Ground Operation Support System
GSFC	Goddard Space Flight Center (Greenbelt, Maryland)
HOSC	Huntsville Operations Support Center
IRIG	Inter-Range Instrumentation Group
kbs	Kilobits per second
kHz	Kilohertz
KSC	John F. Kennedy Space Center, NASA
LCC	Launch Control Center
LEM	Lunar Excursion Module
LIEF	Launch Information Exchange Facility

LOX	Liquid Oxygen
LUT	Launcher Umbilical Tower
MHz	Megahertz
Mid Field	The area within 50 feet to 1500 feet of a launch pad
MCC-H	Mission Control Center - Houston
MSC	Manned Spacecraft Center (Houston, Texas)
MSFC	Marshall Space Flight Center (Huntsville, Alabama)
MSFN	Manned Space Flight Network
MSOB	Manned Spacecraft Operations Building
MSS	Mobile Service Structure
Near Field	The area within 50 feet of a launch pad
NRZ	Nonreturn to Zero
ODOP	Offset Doppler Tracking System
OMSF	Office of Manned Space Flight
PAM	Pulse Amplitude Modulation
PCM	Pulse Code Modulation
PDM	Pulse Duration Modulation
PSB	Precision S-Band Tracking System
PTCR	Pad Terminal Connection Room
RF	Radio Frequency
RZ	Return to Zero
SCTV	Space Craft Television
SRT	Supporting Research and Technology
TEL IV	AFETR Telemetry Station at KSC
UDOP	Ultra High Frequency Doppler Tracking System
UHF	Ultra High Frequency
VAB	Vertical Assembly Building at Complex 39
VHF	Very High Frequency

SECTION 1

PROJECT SUMMARY

The objectives of KSC launch instrumentation systems under the cognizance of the KSC Director, Information Systems are basically to provide the following for prelaunch and launch operations:

a. Development and operation of ground instrumentation systems for telemetry, flight television, and special-purpose RF systems.

b. Special tracking systems research, development, and operation for early launch phase of flight.

c. Geophysical, facility, and special-purpose measuring systems.

d. Data display and data transmission systems.

e. General instrumentation support laboratories.

f. Timing correlation and distribution.

g. Coordination and resolution of all NASA frequency allocation problems at KSC occurring in connection with prelaunch and launch operations.

h. Instrumentation systems reliability.

i. Analytical studies relating to instrumentation systems.

j. Overall launch instrumentation planning and coordination.

k. Processing "quick-look" data and fulfilling test and flight data requirements for the KSC and other data users.

l. Electromagnetic interference (EMI) and compatibility (EMC) monitoring for NASA operations.

m. Operation of a central computing facility for general-purpose, scientific, and business computing at KSC.

These activities are based primarily at the Central Instrumentation Facility (CIF) at KSC. Although the CIF houses the major part of instrumentation equipment and offices, some of the activities must be performed at the launch complexes; so, instrumentation areas are reserved in the LCC, VAB, and launch pads of Complex 39, as well as areas in Complexes 34 and 37. The specific areas and systems at KSC are discussed in this plan.

SECTION 2

HISTORY AND RELATED WORK

The Webb-McNamara Agreement for management of KSC established that NASA would have selected instrumentation responsibilities on Merritt Island. NASA responsibilities were assigned by the Director of the Kennedy Space Center to the Director, Information Systems, and formed the basis for FY-64 Construction of Facilities budget estimates for Launch Instrumentation. Later Interim Agreements implementing the basic Webb-McNamara Agreement (January 17, 1963) increased the scope of KSC instrumentation activities, such as Addendum No. 2 (May 28, 1963) to the Interim Agreement for calibration equipment and services. Addendum No. 1 (May 28, 1963) named the Joint Instrumentation Planning Group as the local coordinating body for KSC and AFETR instrumentation programs.

Intercenter agreements and requirements for prelaunch and launch data are the basic planning information utilized for determining instrumentation equipment requirements and workload. The KSC instrumentation operations on Merritt Island are based on systems which have been devised and developed to prototype status in CY-1962, -63, -64, -65, and -66, operations at Cape Kennedy while supporting Saturn and other NASA programs.

During this development period, the operating concepts for instrumentation systems at KSC were formed. These concepts and the systems which implement them are described from two viewpoints: (1) Instrumentation Systems and Services and (2) Facility Utilization of Instrumentation Activities. Sections 3 and 4 outline the systems and service concepts, and Section 5 describes the KSC facilities associated with instrumentation activities. In the final sections, charts are presented for instrumentation milestones by systems and are supported by manpower and funding projections.

SECTION 3

INSTRUMENTATION SYSTEMS: JUSTIFICATION AND DESCRIPTION

3.1. Computing Equipment

The Central Computation Complex at the CIF is operationally supported by a computer support services contractor under the cognizance of KSC personnel. This complex is performing the following centralized computation and "quick-look" data-reduction support for NASA and NASA contractor operations at KSC and Cape Kennedy:

a. Preflight data reduction encompassing a variety of miscellaneous tasks such as windshear analyses, determination of antenna pointing angles, and prediction of sound focusing phenomena.

b. Scientific planning and analysis performed in such areas as studies of geometric dilution of precision for tracking systems and checking lines of sight for instrumentation sites.

c. Preflight simulation and subsystem evaluation facilitated by support from the Central Computation Complex which monitors performance of the telemetry system by verifying measurement limits and predetermined calibration curves.

d. Real-time telemetry data monitoring accomplished by the Central Computation Complex on data formatted through the CIF telemetry station. The computers can monitor 3,000 telemetry measurements, convert them to engineering units, and provide converted data on request to a real-time data display system.

e. Post-flight "quick-look" data reduction providing microfilm, tabular copies, and graphs of engineering units versus time for all measurements. These data are used for "quick-look" evaluation. Detailed analysis and evaluation of data will be performed at the using Center's or contractor's facilities.

f. Prelaunch test support including computations for evaluation of the performance of the digital guidance computer.

g. AFETR tracking data recorded in "real-time" by the Central Computation Complex. These earth-centered rectangular vehicle position and velocity components are used as input to a KSC computer program to compute NASA special trajectory parameters for MSC.

The KSC Central Computation Complex receives requirements from three basic sources: local KSC requirements, other NASA Centers and/or Office of Manned Space Flight, and stage contractors.

A Division Chief is the level of authority required for local KSC requirements. These requirements are analyzed and evaluated for applicability to computer solution by computer personnel.

Requirements from other NASA Centers and/or OMSF are levied through NASA recognized requirements documents.

Stage contractor requirements are received from the KSC Programs Office. These requirements are evaluated by computer personnel and appropriate recommendations made to the Program Office along with budgetary impact information.

A support capability is maintained at the LCC of Complex 39 to support special-purpose checkout computers operated by KSC. This support includes the following:

a. Assembly of routines for checkout computers.

b. Computations for evaluation of data gathered from checkout computers.

c. Preparation of tape listings and tabulations of data from checkout computer.

Both the Central Computation Complex and the support capability at the LCC of Complex 39 are available for support of contractors at KSC. This includes general data processing for evaluation of checkout data and general-purpose computations.

Except for equipment supporting checkout computers, all Launch Instrumentation computing equipment at KSC is located in the Central Computation Complex at the CIF. The CIF houses a large-scale GE-635 computing system together with high-speed plotters, magnetic-tape data transmission equipment, and computer peripheral equipment. An additional large-scale computing system will provide the Central Computation Complex with capability to support two simultaneous test operations and with backup during a single test. This backup will assure against loss of data during real-time operations and also provide additional capability for general-purpose computing to help fulfill the needs of KSC and NASA contractors at KSC. Figure 1 shows a flow diagram of computer operation for "quick-look" data reduction.

All business computing (ADP) equipment has been transferred to the CIF, to be operated under the control of the Director, Information Systems. These applications will be converted to the GE-635 system as programs can be rewritten. For a more detailed description of ADP operations, consult the Annual ADP Planning Document, published by the Director, Information Systems, May 15, 1966. The following commercial applications, slated for eventual conversion, are in terms of software system programs. The references in parenthesis at the end of each subparagraph are to the appropriate pages in the Annual ADP Planning Document. (Note: support of launch operations takes priority over all other ADP operations.)

a. Reliability System. Reliability consists of six systems: Failure Data System, Customer Quality Inspection System, Manned Spacecraft Center Quality Control System, Equipment Data System, Time and Cycle System, and the North American Quality Control System, (II-9 through II-11).

b. Procurement. This system consists of three ADP systems: Procurement System, Vendor System, and the Purchase Order System, (II-11).

c. Financial Management Office (FMO). The FMO is supported by eight ADP Systems. Transactions from FMO are applied to a computer process (Figure 2), where they become input for six of the FMO's ADP systems. The other two systems, payroll and labor, receive their inputs directly from FMO. The ADP systems are the Daily Commitment System, Cost Accounting System, Program Operating Plan (POP) System, Travel Accounting System, Contracts and Grants System, Monthly Accounting Report System, Payroll System, and Labor System, (II-12, II-13).

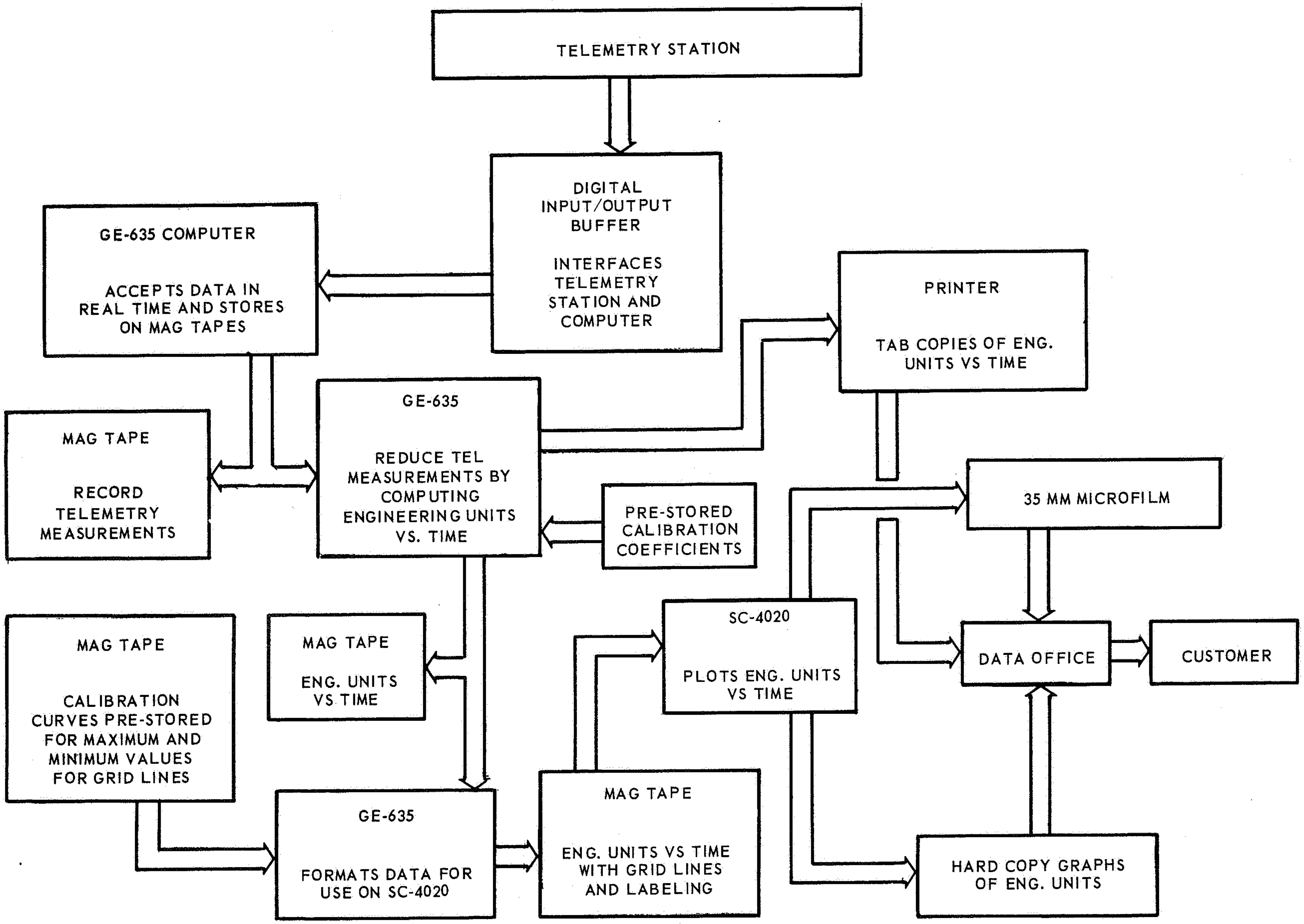

Figure 1 - Flow Diagram of Computer Operations for Quick-Look Reduction of Data to Engineering Units

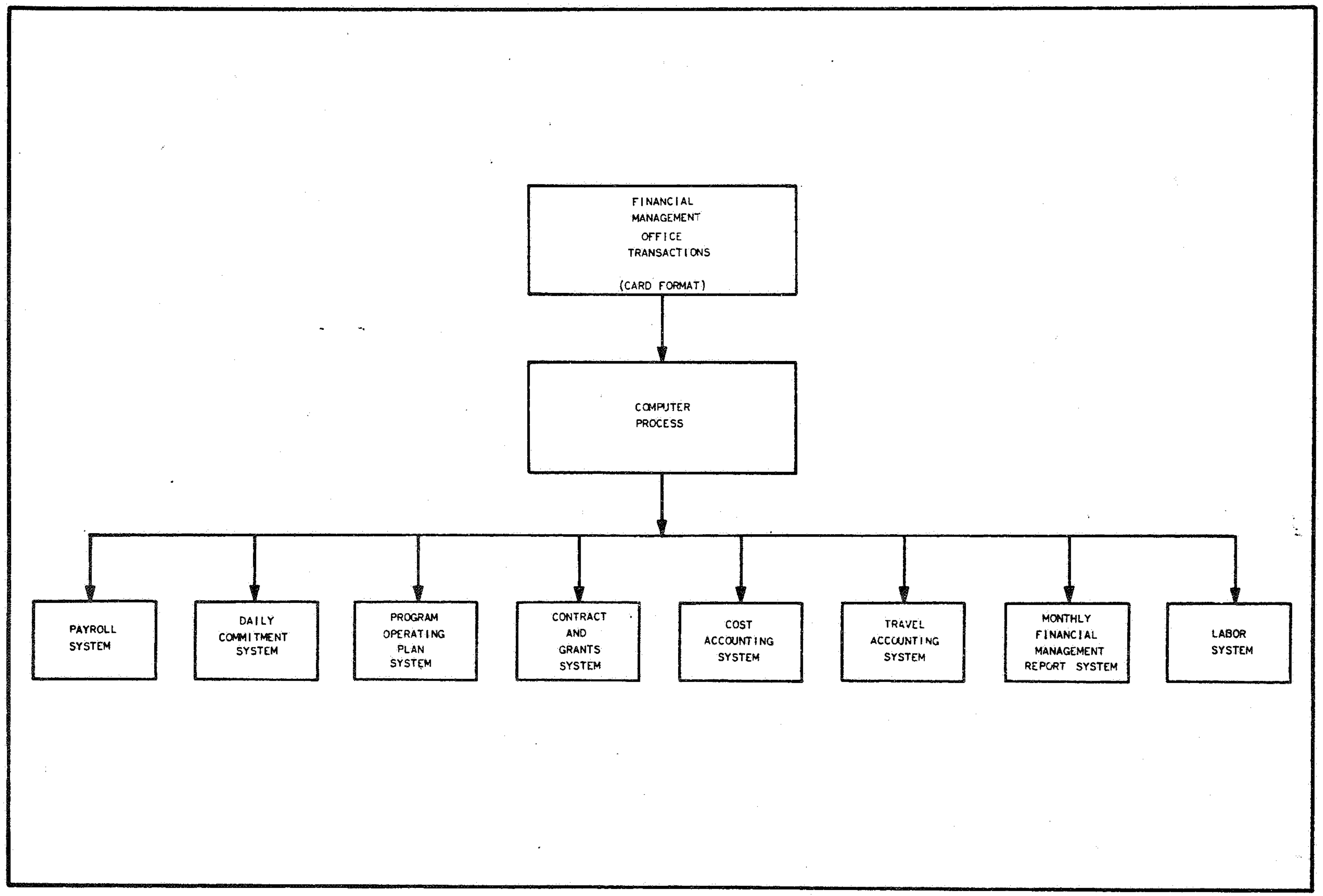

Figure 2 - Financial Management Office

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REAL TIME IN LINE SUPPLY SYSTE

SUPPLY MANAGEMENT

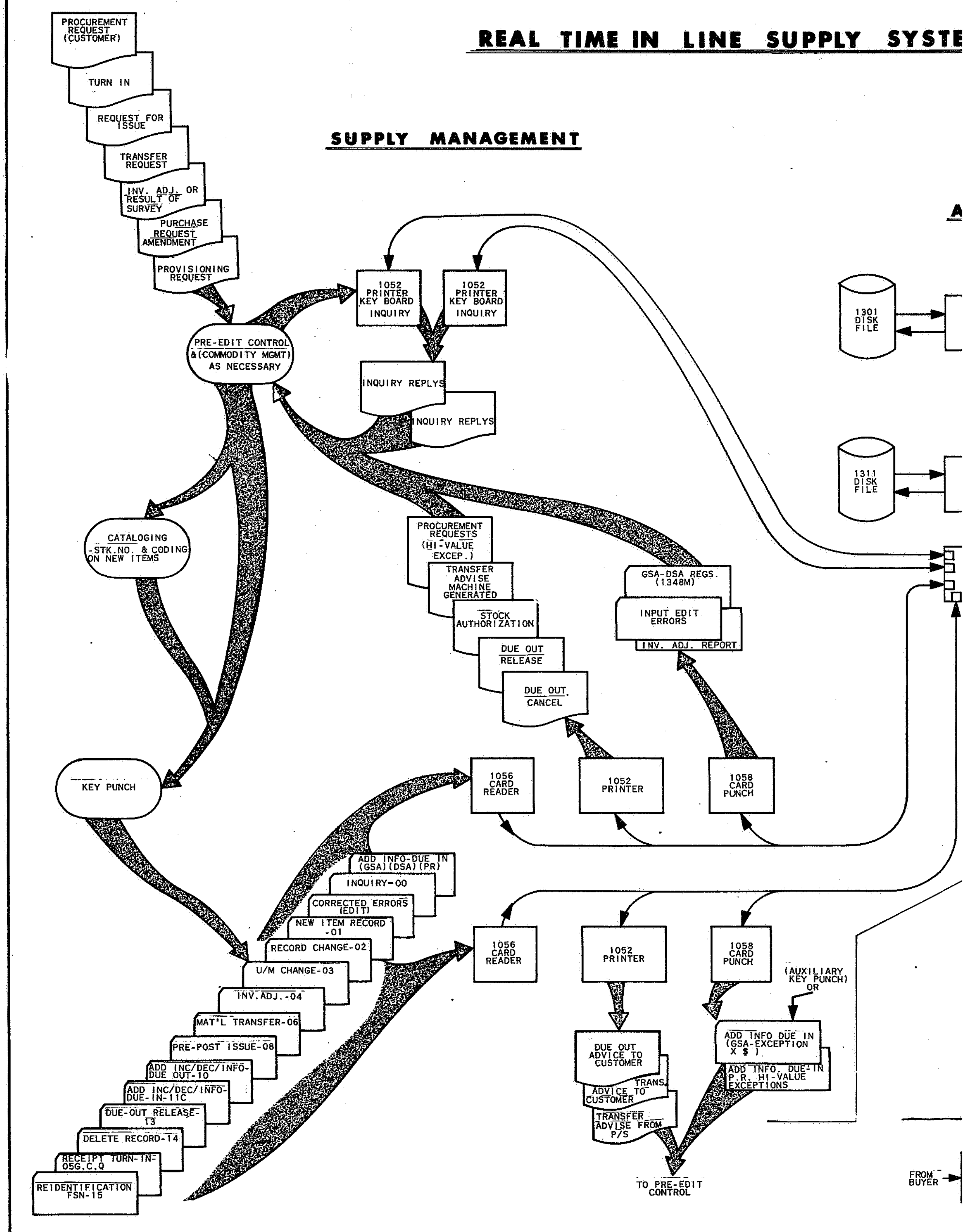
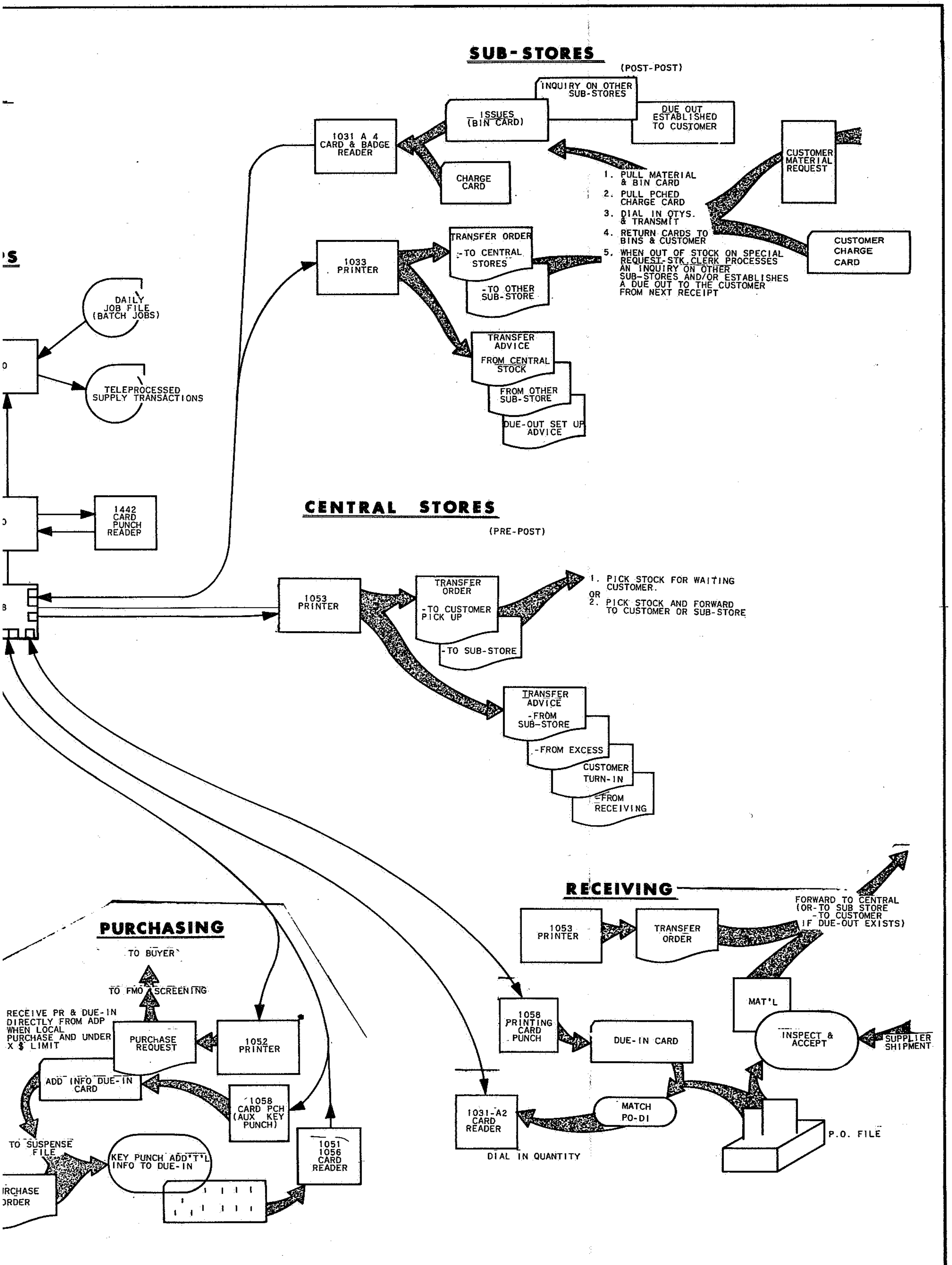


Figure 3 -



'oposed Inventory Management System

d. Pre-post Inventory Management. This system (Figure 3) maintains stock levels and financial stock control data. This provides definition of reorder points and maintenance of procurement, shipping, and updated inventory records. Several new developments, as well as the adoption of the Standard Federal Stock Number System, have made it necessary to implement a comprehensive inventory control system, (II-13).

Other systems include the Calibration System, Aerospace Ground Support Equipment (AGE) System, Preventive Maintenance System, Program Scheduling Analysis (PERT) System, Launch Vehicle Operations (LVO) Documentation Support Systems, Personnel System, Classified Documents System, Contract Surveillance System, Work Order Control System, Security System, Scientific and Technical Aero Report (STAR) System, and the Countdown System.

3.2. Timing and Countdown System

The KSC Timing System performs the following specific tasks:

a. Provides an extremely accurate and stable source of timing signals at rates and in formats consistent with the demands of all area instrumentation, monitor, control, display, and analysis requirements.

b. Maintains timing synchronization with, and provides precision discrete frequency signals reference to, universal primary standards and the Air Force Eastern Test Range.

c. Generates, distributes, and displays countdown timing signals, and distributes these with timing and frequency signals, to all NASA and other activities within KSC.

d. Distributes launch-related, and other event correlation signals, throughout KSC.

The KSC Timing System consists of equipment installations at the Central Instrumentation Facility (Central Timing Station) and remote sites at the Launch Control Center (LCC), Vertical Assembly Building (VAB), Pad Terminal Connection Rooms (PTCR), Launcher Umbilical Towers (LUT), Manned Spacecraft Operations Building (MSOB), and the Spacecraft Fluid Test Complex for the particular service required in those areas. Figure 4 indicates the central station equipment and distribution layout of the system.

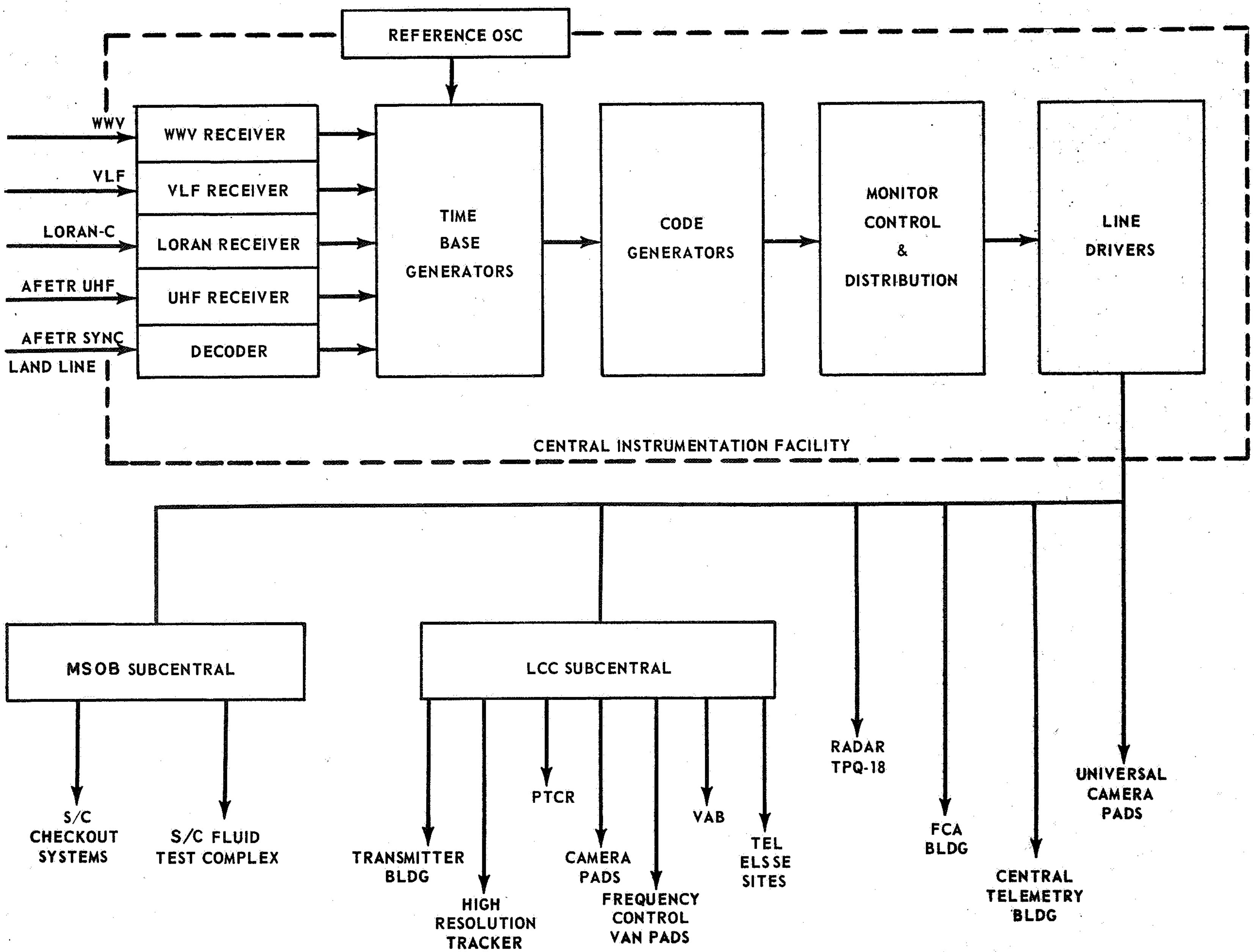


Figure 4 - KSC Timing System

Prior to occupancy of the CIF, timing distribution originated from the MSOB at the beginning of the Gemini program, and extended throughout the Fluid Test Complex. The KSC Timing System signals are made available to AFETR installations at KSC. The AFETR will continue to supply timing to KSC installations on the CKAFS.

The Central Timing Station contains the necessary equipment to generate accurate time and frequency signals, which are distributed via cable to all KSC locations. Each of two identical sets of equipment located at the Central Timing Station consists of a reference oscillator, a time-based generator (accumulator), code generators, and timing signal transmitters. This redundancy provides for the confidence level consistent with the required reliability factors. Sequential comparison of this redundant generation is made, continuously and automatically, with AFETR generation to assure synchronization. Provision for this is made by wire interface at the Banana River Repeater Station and by reception of the UHF AFETR time transmission. Time and frequency signals are continuously compared with signals received from National Bureau of Standards and the U.S. Naval Observatory radio transmissions in order to verify the precision of generation.

Timing signals are transmitted from the Central Timing Station (in the CIF) via cable to major locations. Timing terminal units are supplied to the rack-mounted equipment areas of using activities. A modular design approach allows expansion of the components of the system to accommodate the timing requirements of anticipated future activities. Updating the precision of generation is accomplished by additions to the Central Timing Station only. Subcentral (slave) distribution stations carry this distribution to the terminal units. A systems engineering group provides special terminal unit development capability.

Timing and countdown signal requirements are received from all NASA activities and stage and mission contractors. These requirements are reviewed, validated, and integrated into the timing system. Presently

105 signals are distributed from 32 terminal units. The future capability for all KSC requirements shall be 250 signals from 70 terminal units. Fourteen sources of countdown time are presently being distributed over 5 networks to 55 displays. Ultimately, for the Saturn/Apollo program, 26 sources of count will be distributed over 7 networks to 400 displays and retransmission terminals.

3.3. Geophysical Measuring Systems

The acoustic data measuring system for KSC will be capable of measuring the noise environment produced by large launch vehicles. Simultaneous measurements will be made in the immediate area of the launch pad and at distances several miles from the launch pad. Acoustic data (sound pressure levels and frequency) will be recorded on multi-channel tape recorders for later analysis. The system will have a 56-channel capacity in the area at or adjacent to the pad with microphones located on the LUT, in the PTCR, and at various positions around the launch pad. Recording equipment for these measurements will be located in the PTCR and controlled remotely from the LCC. Additional channels of acoustic measuring and recording equipment will be portable for use in areas outside KSC. Seismic and blast pressure data from the launch area will also be recorded.

The meteorological measuring system for KSC will perform the following tasks: provide a detection system for electrical storms, track electrical storm paths, and measure magnitude of lightning strokes on structures and induced voltages in circuits; gather data on existing surface wind conditions; and provide information on relative humidity, temperature, barometric pressure, and solar radiation. The measuring system will provide direct readouts and recording capabilities.

Anemometers and lightning instrumentation will be installed on each LUT and MSS to furnish data during transit with direct readouts

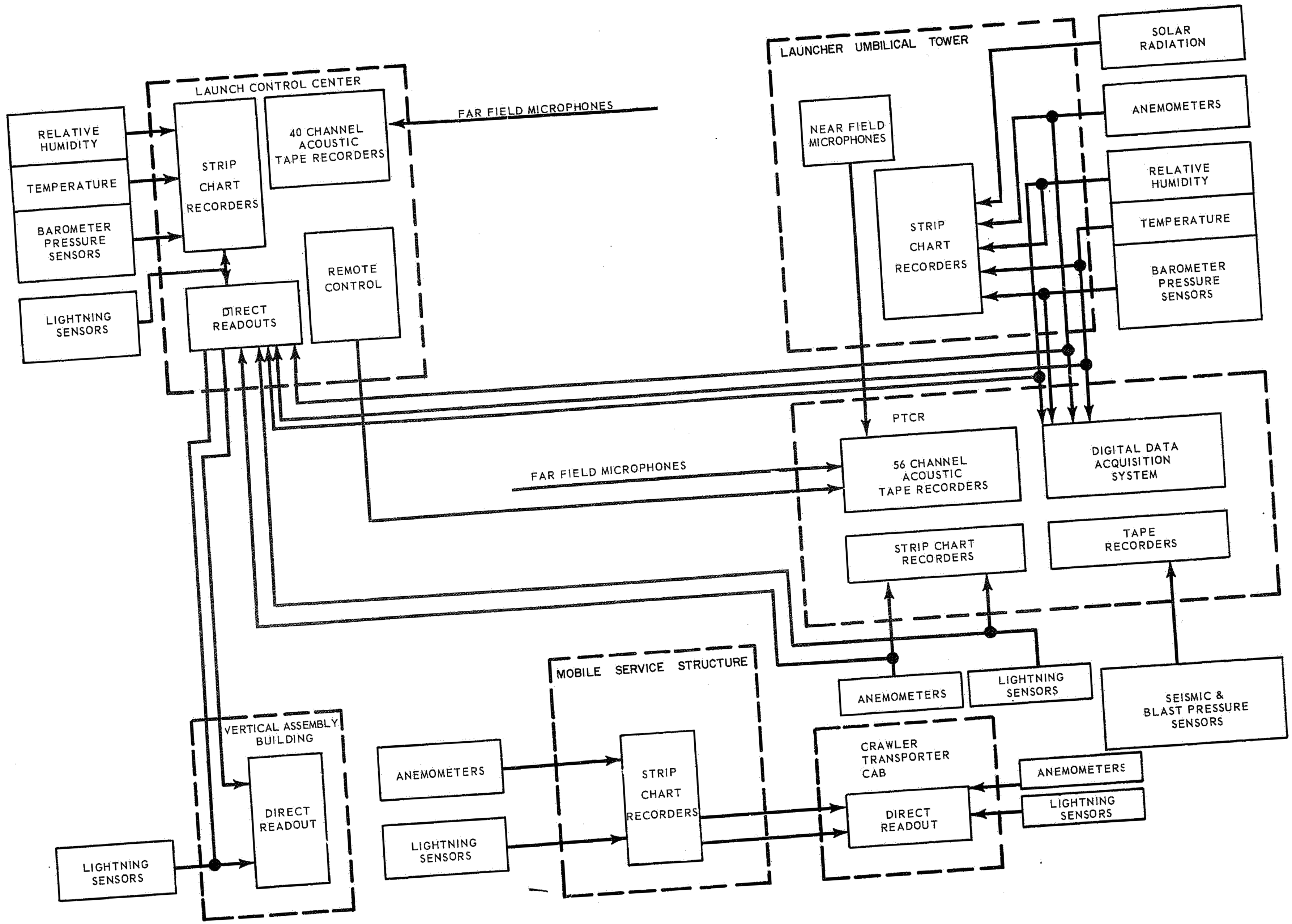


Figure 5 - Geophysical Measuring System

in the crawler-transporter cab. Anemometers and lightning instrumentation will also be located near the launch pad. Data from these devices will be recorded on strip-chart recorders along with relative humidity, temperature, barometric pressure, and solar radiation data. The Digital Recording System (DRS) located in the PTCR will be used during launch to record selected meteorological data in digital format. Direct readouts in the LCC will provide a constant monitor on developing wind and lightning conditions.

The wind measuring system at Complex 34 consists of six wind direction and velocity transducers. The data are recorded in the blockhouse on strip charts. Real-time meter readouts are provided to the Deputy Director for Launch Operations console. The Complex 37 system will be identical except that any six of eight locations may be selected from the blockhouse for monitoring.

The lightning warning system at LC 34 consists of potential gradient and corona current sensors located on top of the blockhouse. The values are recorded on strip charts on the first floor of the blockhouse and monitored during critical tests. Safety personnel are notified when a potential gradient of 2.4 kv/m is exceeded. The system at LC 37 will be identical to the system at LC 34.

The acoustic systems at LC 34 consists of 36 channels each. Microphones can be mounted anywhere within the complex and the data are recorded on FM magnetic tape in the blockhouse. The acoustic systems at LC 37 will be identical to the systems at LC 34. (All systems at LC 37 are down for modifications to the complex at present.)

The hazard monitoring systems at LC's 34, 37, and 39 will provide and maintain instrumentation to detect explosive or toxic gas leakage, propellant contamination, and hydrogen fire detection. The hydrogen fire detection system will monitor the liquid and gaseous hydrogen facilities. The hydrogen fire detection system will consist of a hydrogen fire detector system (HFDS) and a hydrogen fire TV system (HFTVS). The HFDS will be the prime means of fire detection in which UV or IR detectors will be utilized to provide continuous monitoring.

AFETR will provide standard weather services for KSC launch operations. Specialized weather research conducted by NASA-KSC/MSFC will include meteorological observations using the 500-ft. meteorological tower at KSC and the AN/FPS-16 radar on Cape Kennedy.

3.4. Facility Measuring Systems

The facility measuring systems at Complex 39 consist of a vibration data acquisition system and a digital recording system. Figure 6 illustrates the general configuration of these systems. Transducers, located throughout the launch facilities, will be installed separately as required for each launch or test.

The vibration data acquisition system at Complex 39 will have a capability of 336 simultaneous measurements; 288 sensors will be located throughout each LUT and 48 sensors will be located at each of the pad-fixed facilities. The system can record data while the LUT is at the VAB, in transit between the VAB and pad, and at the pad. The system is controlled from the PTCR when the LUT is at the pad. The vibration system includes transducers, signal conditioners, calibration equipment, magnetic tape recorders and playback equipment, and an automatic system test capability. The entire system will be capable of operating continuously for five days with no adjustments required. Signal conditioning will permit data acquisition by both piezoelectric and strain gage transducers. Information bandwidths will be 2000 and 500 cps. The data will be processed and analyzed by an automatic wave analysis system in the CIF.

The digital data recording system at Complex 39 will initially have a capability of 600 simultaneous measurements at each LUT and pad combined. This capability can be expanded in groups of 100 channels. The

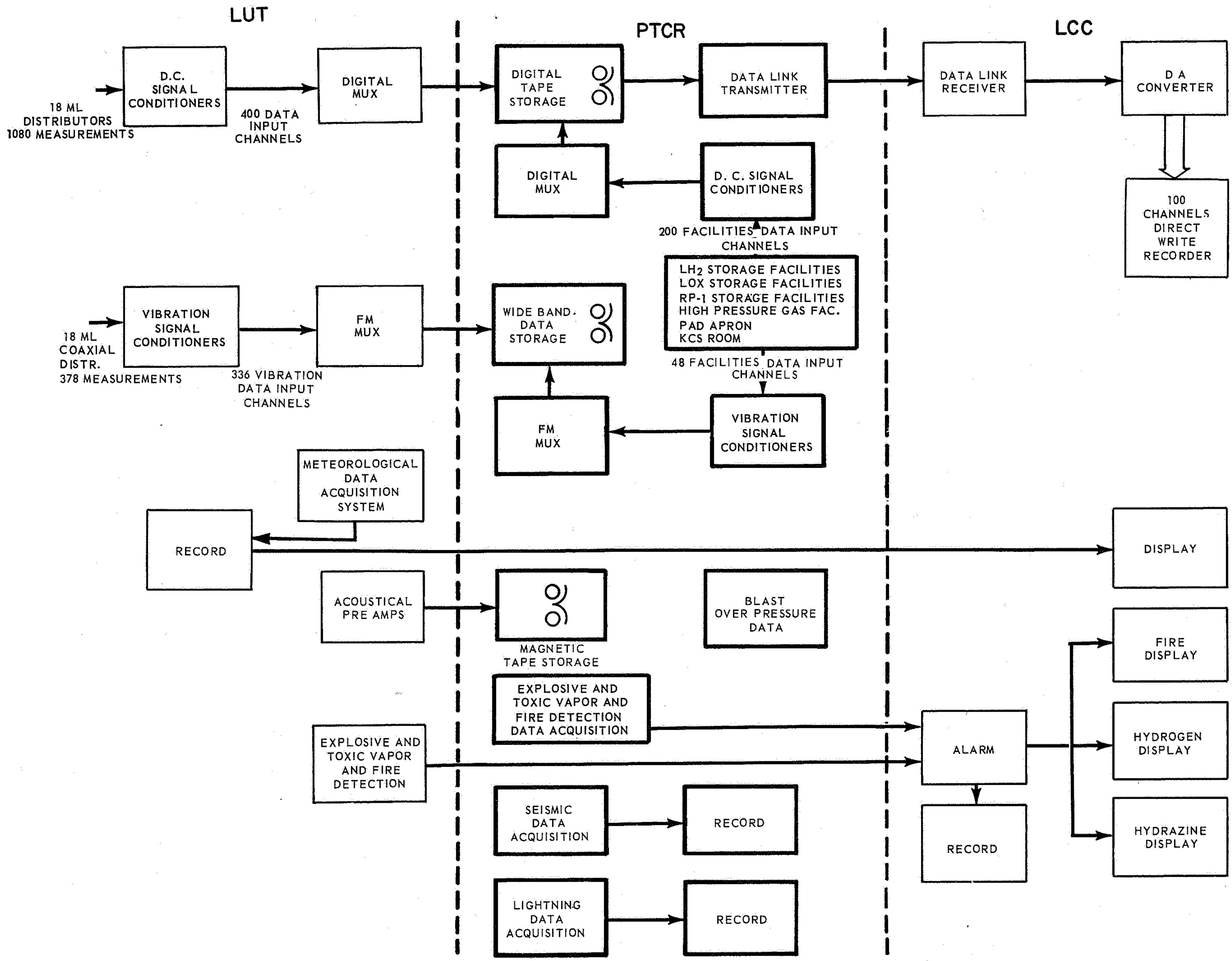


Figure 6 - Facilities Measuring Systems, C

initial capability will include 400 channels on the LUT and 200 on the pad. The use of versatile types of signal conditioning and multiplexing permits many types of measurements to be made: pressure, temperature, strain, flow, rotational speeds, liquid level, voltage, displacement, current, frequency, hydrocarbon content, moisture content, relative humidity, and others. For simplification of maintenance and for versatility, plug-in modules are used throughout the system.

An automatic checkout system (performance analyzer) will be included as part of the data system. The performance analyzer will automatically verify the data system performance. This equipment will be operated either locally or remotely and either manually or automatically. Low-frequency analog data signals will be conditioned for acceptance by the digital data recording system, which records data in digital computer format on magnetic tape and can transmit data to the LCC for real-time recording and display.

To support the measuring capability, laboratories at the CIF are available to design, develop, test, and maintain instrumentation for routine and special measurement requirements.

Component design and development is performed at the CIF to maintain state-of-the-art in areas of measuring transducers, signal conditioners, data acquisition systems, and recording media; to design and build prototype state-of-the-art measuring instrumentation subsystems and components; and to design and develop methods and hardware for making special and unusual measurements as may be requested.

Environmental testing facilities and services at the CIF include temperature, altitude, humidity, pressure, acceleration, vibration, shock, salt-spray, fungus, and dust. These facilities will be suitable for testing to such specifications as MIL-STD-202C and MIL-E-5262C.

3.5. Telemetry Station

A multipurpose telemetry station is located in the CIF to receive and process telemetry and other data from prelaunch tests, launch, and flight of NASA launch and space vehicles. The telemetry station has a versatile capability:

a. Acquisition of vehicle and spacecraft radiated signals by antennas at CIF and via hardwire data links to AFETR and NASA stations. Acquisition of vehicle and spacecraft non-radiated signals via hardwire data links to the launch areas at KSC. Acquisition of AFETR instrumentation data, such as meteorological radar data via hardwire data links.

b. Receive RF signals in currently authorized VHF telemetry bands with limited capability in the S-Band (UHF). Receivers in the station are of the "plug-in" type that will permit complete conversion to S-Band telemetry when this is authorized.

c. Process PAM, PDM, and PCM time division signals in authorized telemetry band.

d. Process FM/FM (analog) and single sideband (SSB) frequency division signals in the authorized telemetry bands.

e. Record,both predetection and post detection, on magnetic tape all telemetry data acquired by the station. Record, playback, and make copies of processed data, both analog and digital. Signal strength of all channels is recorded.

f. Convert all telemetry data (with exception of SSB) acquired by the station to computer-compatible digital format for real-time computer reduction of data to engineering units for real-time display and hard-copy printouts. Also, convert data to digital format for transmission to MSFC via LIEF and to MSC via ALDS.

g. Record processed data on strip-chart recorders: direct-write recorders for data that vary slowly with time and oscillograph recorders for data that vary rapidly with time.

The station is composed of four modules, each of which may be operated independently or any combination of them may be interconnected for combined operation. The general capabilities and primary output

Table 1. CIF TELEMETRY STATION CAPABILITY

MODULE	NUMBER OF TELEMETRY DATA CHANNELS					TAPE RECORDERS		STRIP CHART RECORDERS		REAL-TIME OUTPUT			
	PAM*	PDM*	PCM*	FM/FM*	SSB	Predet.	Post Det.	Oscillograph (36 channel)	Direct Write	ALDS	LIEF	CIF Computer	Strip Chart Recorders
1	12	12	4	95		2	2	10	16	Yes	Yes	Yes	Yes
2	12	12	4	95		2	2	10	16	Yes	Yes	Yes	Yes
3	--	--	6	40		2	--	2	4	Yes	Yes	No	Yes
4	--	--	6	40		2	--	2	4	Yes	Yes	No	Yes
Single side-band + constant bandwith					6	2	2	4	--	No	No	No	Yes

NOTE: *The maximum total number of PAM, PDM, PCM, & FM/FM channels that can be handled by a single Data Core is 32. Any combination, up to 32 total channels, can be processed in real time.

interfaces for the modules are tabulated in Table 1. The need for four modules is dictated by three requirements: (1) the ALDS, a redundant system, requires two sources of input data (thus two modules are mandatory for one launch vehicle/spacecraft operation); (2) two concurrent prelaunch operations have been used as the design criteria for the station (thus two modules per vehicle/spacecraft); and (3) the operational philosophy is to commit the real-time module to a specific vehicle/spacecraft from the FRT through launch to prevent disturbing the interconnections of the equipment after it is present in the FRT.

The real-time digitizing of telemetry data utilizes a unique system developed at KSC. This system, the Data Core, is shown in relation to the rest of the telemetry station in Figure 7. A block diagram of the Data Core is shown in Figure 8 and is described as follows:

Data Core is an electronic system which will receive a variety of types of analog and digital input data (including PCM, PDM, PAM, and analog signals) from a multiple number of asynchronous sources and will process these data into digital format that can be utilized directly by a high-speed digital computer and/or retransmit selected data to MSC and MSFC, and to quick-look digital or analog display devices. The Data Core is composed of four major subsystems: input data converters, digital scanner, computer interface, and data display distributor.

Data converters for PCM, PDM, PAM, and analog signals are the input part of the Data Core. The PCM data converter consists of a bit rate synchronizer, code synchronizer, serial-to-parallel converter, and PCM addressor. As an example of data converter operation, the PCM converter operation is described as follows:

The bit rate synchronizer will operate with any frequency between 10 and 600,000 bits per second with an NRZ (nonreturn to zero) code and 5 to 300,000 bits per second for RZ (return to zero) code. It can establish

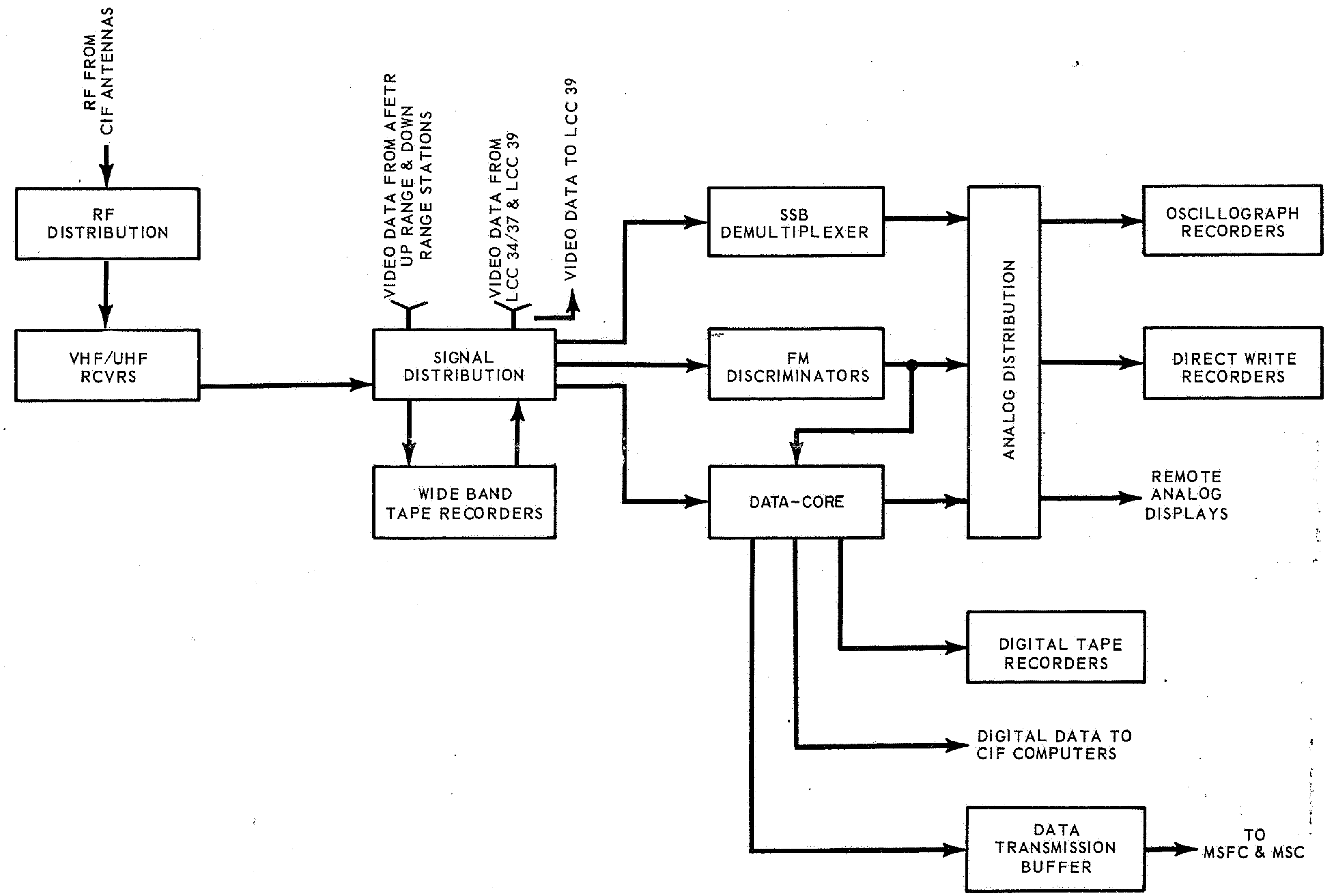


Figure 7 - Block Diagram of One Module in CIF Telemetry Station

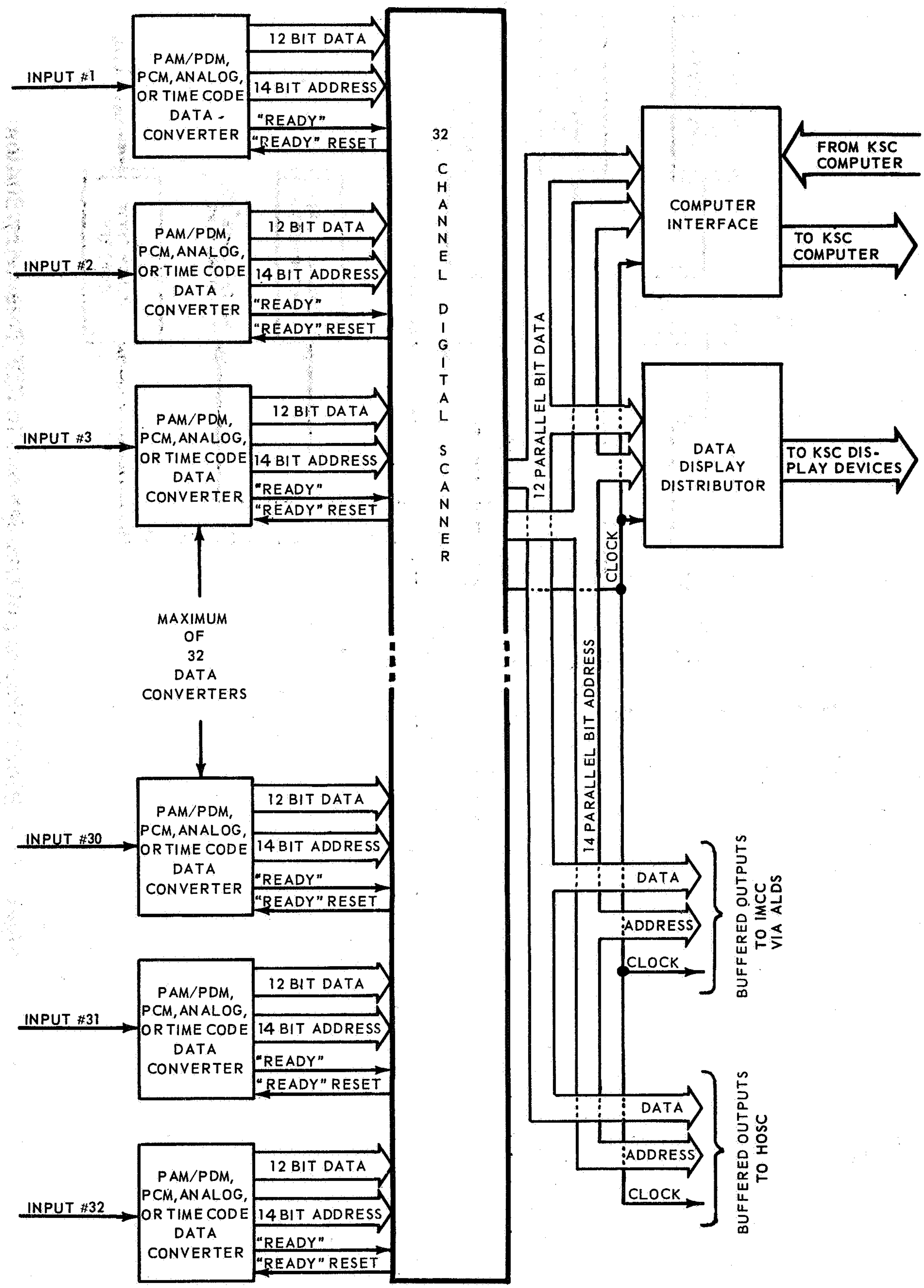


Figure 8 - Block Diagram of Data Core

clock timing synchronization with the incoming serial wavetrain and also filter the incoming signal to improve the signal-to-noise ratio. The input wavetrain will then be regenerated into a noise-free, constant amplitude, serial output wavetrain.

The code synchronizer will process the regenerated serial wavetrain from bit rate synchronizer and establish timing synchronization of the internal programs with the information contained within the coded words of the wavetrain. It will have three independent 32-bit synchronization code pattern recognizers.

The serial-to-parallel converter breaks the serial data train into meaningful digital words and presents these as parallel data words to the digital scanner. The converter will utilize the timing furnished by the code synchronizer to perform this conversion to parallel.

The PCM addressor will utilize the timing and other information from the code synchronizer to look up in a core memory programmed and stored address codes to be presented to the digital scanner along with the data words from the serial-to-parallel converter. The addressor will give the "Ready" signal to permit the digital scanner to transfer the data and address words to its outputs. It will be capable of generating data addresses for input data rates up to 60,000 per second. The core memory will be capable of storing from 0 to 8192 address or instruction words which are each 14 bits in length. The clear-write or read-restore cycle time of the memory will be 5 microseconds or less.

3.6. Real-Time Data Display

The Real-Time Data Display System arranges information format and display computer processed telemetry information, radar information, weather information, TV information from onboard vehicles and ground cameras, and preflight data profiles. The recording and display equipment includes: consoles, recording and display racks, rear screen TV projector, reviewing screens, data evaluation boards, timing and countdown display, and data evaluation tables.

The data flow diagram for the Data Display System is described with reference to Figure 9 as follows: Computer output data are fed into a "Buffer/Distributor" where the data are buffered and routed to the proper display channel. Then the data are converted by the "Data Formator and Converter" into a video format. The converter refreshes the data at the 30 frame-per-second TV rate thus alleviating the computer workload. Graphs, maps, and charts are stored on 35mm slides where a TV camera (vidicon) converts this information into a video format. Other forms of data are converted by TV cameras or are already in video format and can be interleaved directly into the system. The video data are then displayed on TV monitors at consoles and projected onto large screen displays. Controls at the consoles allow the operator to select and expand the data displayed on the monitor as required.

Only one console has the capability of calling up the telemetry displays to be presented. Either an alphanumeric or graphic presentation of a particular measurement may be selected. However, as for the AS-201, present capabilities allow only one display to be dialed at any given time. This display can then be presented on all consoles, if so desired. Future capabilities will allow 30 different displays to be presented simultanously.

The recording and display racks make up two sections, each containing seven racks. Each section contains three TV displays, and three Ink Oscillograph Brush recorders. OTV is presented on the rack-mounted TV displays. The recorders present analog data in direct voltage readings. All data available in the Data Core can be patched to the recorders, but only 48 recorder channels are available for display at any one time. Future capabilities will provide additional recorders.

The rear screen TV projector presents TV displays (OTV, commercial TV, and telemetry data) events, and slides containing stored

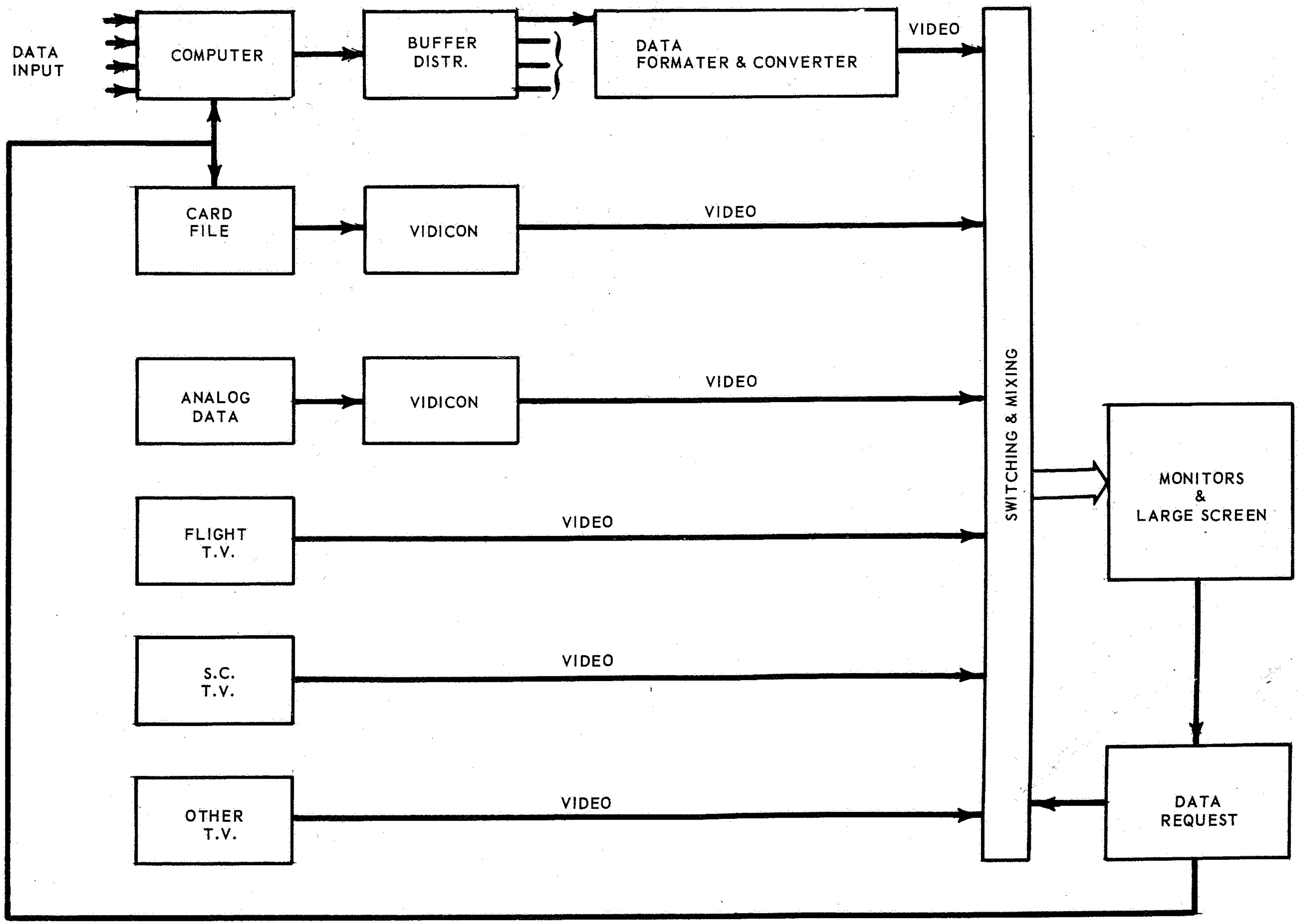


Figure 9 - Block Diagram of Real-Time Data Display System

data for reference use. Future capabilities will provide additional projectors.

The equipment for converting the data into video format is located in the CIF. Video switching, data request and display monitors, and large screen projectors will be located in the LCC at Complex 39.

3.7. Antennas

The antennas located at the CIF Antenna Field are used to acquire telemetry, flight television, and vehicle tracking signals. The Antenna Field, located approximately one mile north of the CIF in an RF quiet zone to minimize RF interferences from equipment at KSC, consists of a small building containing antenna control, receiving equipment, two 19-foot, two 24-foot, and two 6-foot parabolic antennas, flight television equipment, special-purpose RF equipment, and laboratories.

The gain and sensitivity features of the antenna systems provide a nucleus capability for work in areas of general data improvements, applied research in electronic tracking techniques, flame plasma noise studies, and flight TV and telemetry technology. The Antenna Field serves as one of several sites of the ODOP prototype tracking system.

Other antenna systems at the CIF Antenna Field include arrays of barrel-type antennas for the 136-MHz Minitrack satellite tracking system, helix antennas for general-purpose test work, communication antennas, and an array of small special-purpose antennas.

An array of antennas is located on the roof of the CIF to acquire telemetry and flight television signals when the ambient RF noise level at KSC can be tolerated.

The new mission (June 1965) of performing business computing for KSC in the CIF has resulted in plans to move some of the electromagnetic hazard research and control laboratories (see Section 4. 3) to the Antenna Field as well as moving most of the special-purpose RF equipment (see Section 3. 9) to the Antenna Field. This equipment had originally been programmed for the CIF.

3. 8. Flight Television Station

The Flight Television Station receives, demodulates, records and processes data from vehicles for real-time display and kinescope recording. This generalized system is capable of detecting video information in several transmission modes in both amplitude modulation (AM) and frequency modulation (FM). A prototype system, operational on Cape Kennedy, has been used since SA-5 for Saturn and Pegasus TV. The CIF Flight TV Station has the capability to accommodate flight TV at 860, 1705, and 2200 MHz. This flexibility enables the CIF to support existing systems as well as proposed ones for later versions of the Saturn vehicles.

3. 9. Special-Purpose RF Equipment

Special-purpose RF equipment is available at the CIF Antenna Field for use on special projects and one-time mission requirements. This equipment is modified as needed to meet requirements. Examples of use of the special-purpose RF equipment are ground station receiving of signals from special tracking beacons, payload telemetry receiving, receiving signals from systems operating in nonstandard frequency bands, and in performing field tests on electronic hardware.

3. 10. Tracking System

The ODOP/UDOP Prototype Tracking System is a two-way CW Doppler tracking system that provides the most accurate and reliable velocity and acceleration data available. It is also one of the most accurate and reliable sources of position data. The ODOP Tracking System is necessary during the first 60 seconds of flight of the Saturn IB and V because: (1) optical systems are unreliable due to atmospheric conditions and (2) other electronic systems are unreliable due to multipath. The system is currently supporting the Saturn Program and also, through a reciprocal agreement with AFETR, the Minuteman Program.

During ODOP operations, a transmitted standard reference frequency of 53-1/3 MHz is broadcast to the receiver sites (at least three receivers required for reduction) where it is multiplied to 960 MHz. The transmitter interrogator frequency is 890 MHz minus a frequency bias. The transponder receives the 890 MHz minus bias signal, multiplies it by 96/89, and then retransmits it at 960 MHz minus 96/89 of the bias frequency. The ODOP system utilizes most of the existing UDOP (50 MHz, 900 MHz system) equipment but also takes advantage of newer developments and techniques proved reliable since UDOP was developed.

The ODOP and UDOP Systems are capable of providing both "close-in" data and standard flight trajectory data (continuous with time) to the horizon. "Close-in" data are obtained from tracking equipment located near the launch pad from first motion of the vehicle to 30,000 feet. (See Figure 10 for block diagram of "close-in" system.) Standard flight trajectory data are obtained by using stations on a baseline of greater length and continuously tracking the vehicle to horizon. Data quality, accuracy, and reliability are provided by redundant tracking stations with 100 percent backup capabilities. Good data can be obtained even though any single receiving station is not functioning. These data are in the form of real-time velocity strip-charts and magnetic tape recordings of analog data. Real-time digital data input to the Data Core can be provided.

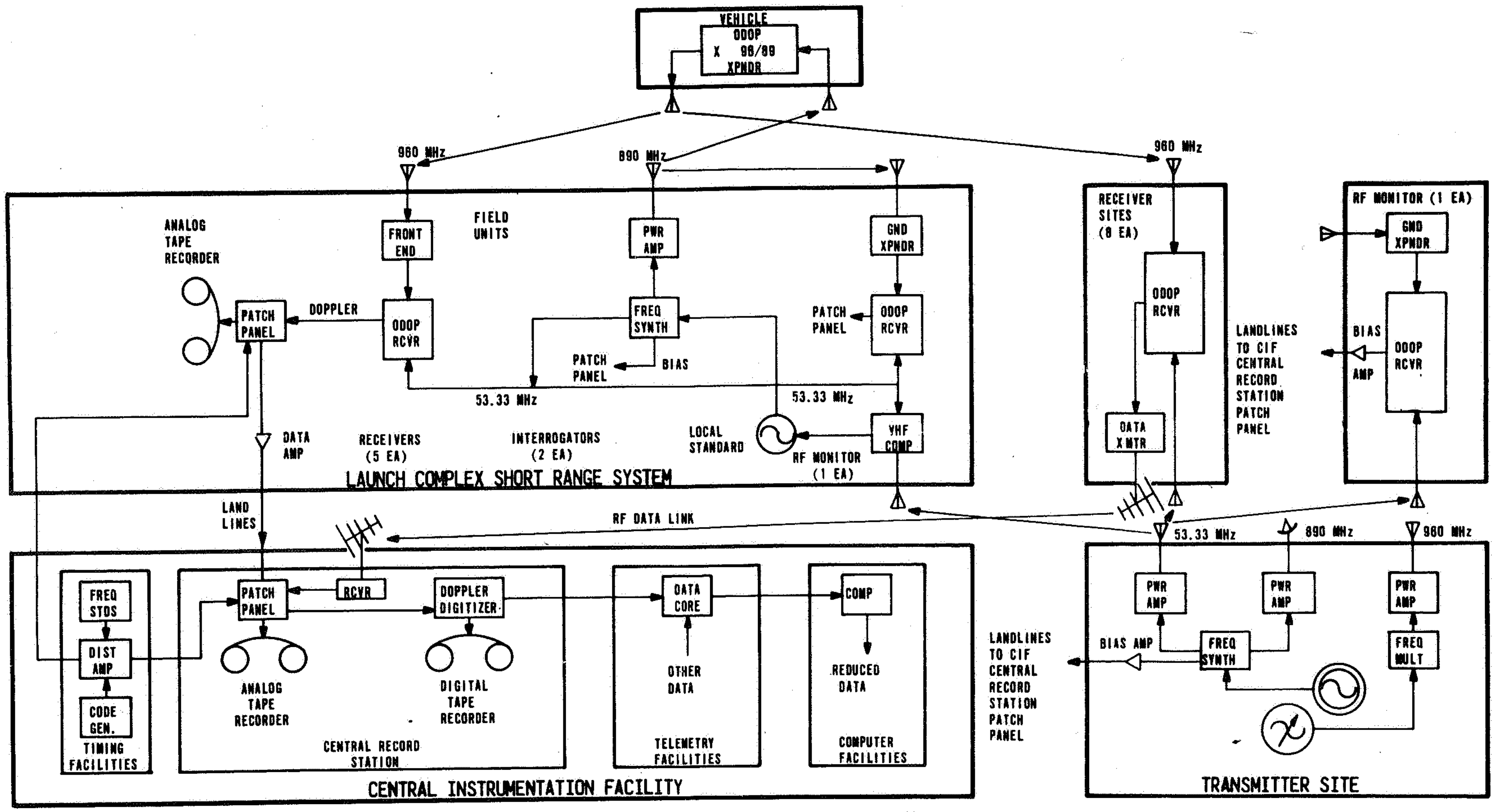


Figure 10 - ODOP Short-Range Tracking System

Prototype Tracking System includes the following areas:

Central recording:	Jade III at CIF
Transmitter facilities at Complex 34 and UTAH on the Cape	
Receivers:	Molly, Cape
	Cactus, Cape
	Complex 34, Cape
	Complex 37, Cape
	Program, Cape
	Margo, Merritt Island, near VAB
	Metro, near Merritt Island Airport
	Tango, mainland, Titusville-Cocoa Airport
	Pluto, mainland, inland west of Cape
Planned Facilities:	ODOP Transmitter Facility near VAB
	Receivers at Complex 39
Planned Data Handling:	Digital tracking data available to computer facilities through the Data Core (early 1966).

3.11. Data Handling Interfaces

The CIF is the central interface at KSC for acquiring prelaunch and launch data from Saturn Launch Complexes and the AFETR, and for transmitting the data to other NASA Centers. In the following paragraphs emphasis is placed on a brief detailing of data handling interfaces into and out of the CIF.

3.11.1. Interface with AFETR

Real-time data from the AFETR telemetry stations (Tel IV) at KSC will transmit receiver outputs to CIF. These signals will be multiplexed on to wideband (4.5 mc) cables so that five signals can be transmitted on a single channel. In addition, data from the downrange stations (Antigua, Grand Turk, and Grand Bahama Island) will be transmitted to the CIF via cable through the X-Y Building at Cape Kennedy. The data from the downrange stations will be in a form that has been partially processed so that it can be transmitted on the limited channel bandwidth available on the submarine cable. Data from Tel IV, however, are transmitted in raw form as it comes from the AFETR receivers since this form allows more flexibility and a simpler interface with external facilities. The AFETR interface with CIF is shown in Figure 11.

3.11.2. Interface with MSC

Output digital data from each Data Core are transmitted to the Apollo Launch Data System (ALDS) which is located on the first floor of the CIF. Figure 11 shows the ALDS and its output to two 40.8 kbs data streams for direct transmission to the MCC-H.

3.11.3. Interface with GSFC

A 2.4 kbs output of the ALDS is transmitted to GSFC at Greenbelt, Maryland.

3.11.4. Interface with MSFC

Real-time output of the Data Core (in the CIF) is transmitted to the HOSC at MSFC by means of a LIEF wideband circuit (40.8 kbs). The Launch Information Exchange Facility (LIEF) is a network of communication resources that facilitate close day-to-day real-time data exchange between KSC and MSFC. The two broad areas of support are (1) MSFC advisory support of KSC prelaunch and launch operations and (2) KSC data support of MSFC postflight evaluation. The scope of LIEF services is as follows:

a. Advisory support.
b. Real-time data and data request.
c. Tape-to-tape.
d. Facsimile.

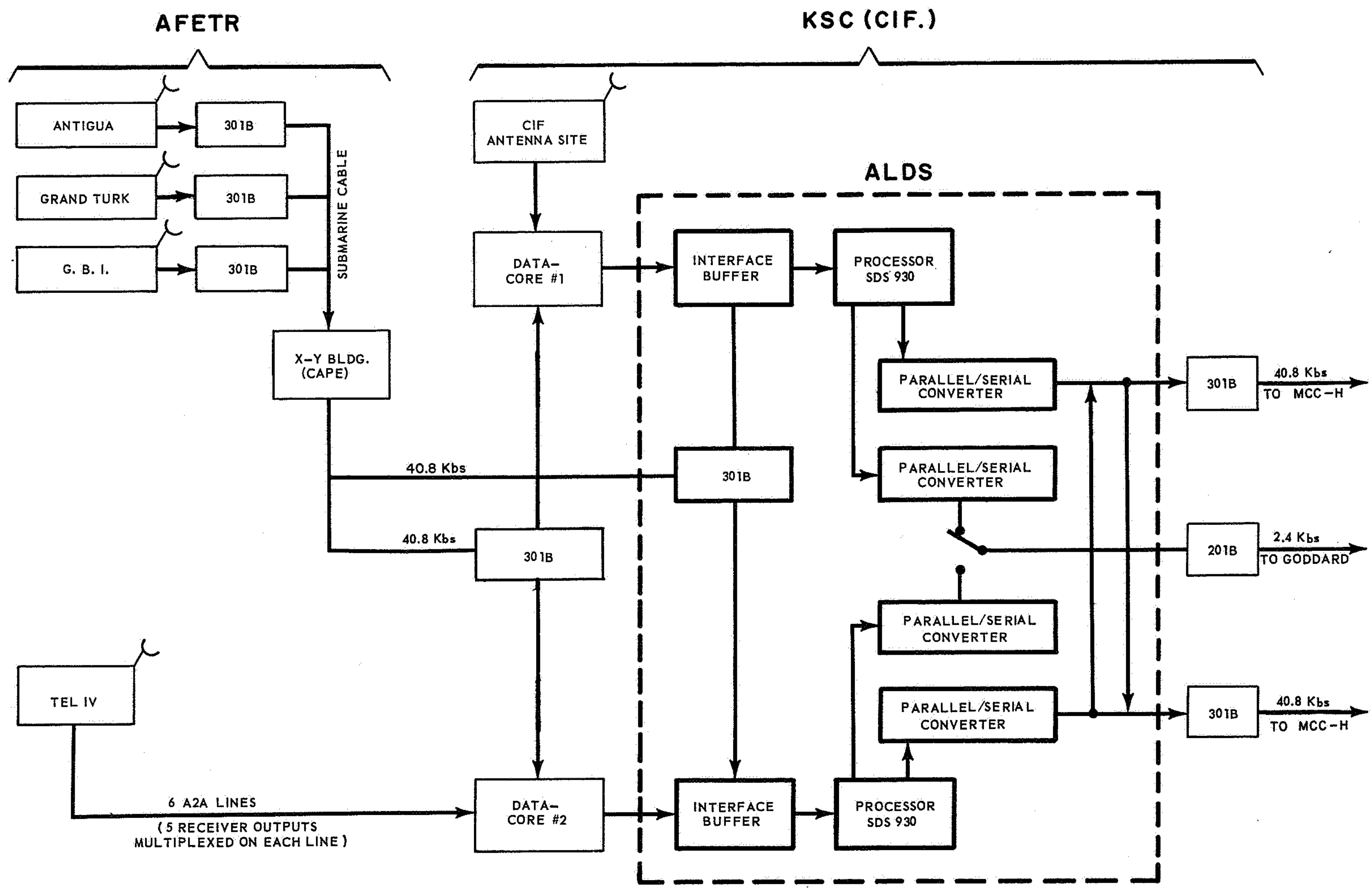


Figure 11 - CIF Data Transmission Interfaces with AFETR, MSC, and GSFC

e. Closed-loop TV.

f. Countdown and liftoff.

g. Classified teletype.

h. Voice circuits.

The LIEF telemetry buffer has a data storage memory which is continuously supplied the most recently sampled values of all space vehicle data from the Data Core. Each parameter is assigned a storage memory address prior to test and this information is supplied to MSFC along with parameter sampling rates.

The real-time data output frame contains 1023 data words of 10 bits each plus a 30-bit sync word. A complete data request instruction assigns a parameter in each of these 1023 word slots by designating the storage memory address for each data word requested. The complete instruction is stored in the data request memory and executed automatically at the 40.8 kbs rate, which is roughly four frames per second.

Digital tape transmission and reception terminals at the CIF consists of a Univac 1004 (40.8 kbs) and an IBM 7702 (2.4 kbs). A second Univac 1004 will be in the LCC at Complex 39.

SECTION 4

INSTRUMENTATION SERVICES: JUSTIFICATION AND DESCRIPTION

4.1. Data Branch

The KSC Data Branch is the focal point in test data handling for NASA tests at Cape Kennedy and KSC. This office coordinates and distributes data for NASA programs such as Apollo/Saturn, Gemini, and Centaur; is responsible for the collection and distribution of data following a launch; is responsible for the flow of test data, including all data from AFETR, to all NASA and NASA contractors at Cape Kennedy and KSC; provides data in the specified format; maintains data files on NASA launches; and is responsible for instrumentation calibration, evaluation, and control of vehicle and launch facility measurements.

The Data Branch at KSC is centered in the CIF and will have operations in the MSOB and the LCC. Close technical contacts will continue to be maintained with all NASA and NASA contractor areas outside KSC.

4.2. Data Analysis

The KSC Central Computation Complex at the CIF is used for quick-look analysis of launch data. Detailed analyses of data are made by the other NASA Centers and by their contractors. Computations required for determining the accuracy of tracking instrumentation for a flight test and analyzing the performance of instrumentation systems are performed at the Central Computation Complex.

4.3. Electromagnetic Hazard Research and Control

Electromagnetic compatibility determination is primarily a KSC in-house function performed in conjunction with launch operations. Research and development contracts are awarded to further the development of various electromagnetic interference techniques or to assist in solving launch-oriented EMI problems (e.g., nonlinear mixing, launch vehicle EMC determinations, propagation anomalies in RF signals, bonding and grounding criteria). During launch periods, activities include the determination of the EMC status of the launch vehicle and of NASA and NASA contractor equipment, propagation measurements of various flight RF systems and electromagnetic spectrum monitoring. During nonlaunch periods, the EMC group will: (1) conduct field operations by making area ambient surveys of the pad and industrial areas and antenna pattern determinations; and (2) perform laboratory testing and suppression of components, and general EMC tests on launch facilities and ground support equipment.

The mobile electromagnetic laboratories are equipped to monitor, direct, or find and analyze radio frequency signals in the region of 150 kHz to 10.75 GHz, to provide signal strength and polarization measurements from in-flight instrumentation, and to test and suppress launch vehicle components. A central laboratory is provided for the testing and suppression (if required) of equipments purchased to EMC specifications, and to conduct or develop in-house R&D efforts in the field of electromagnetic compatibility determination.

SECTION 5

INSTRUMENTATION FACILITIES AT KSC

5.1. Central Instrumentation Facility

The CIF is centrally located on Merritt Island to house KSC instrumentation that serves NASA launch complexes at KSC and Cape Kennedy. Major elements of most of the systems described in Section 3 are at the CIF. Thus, the CIF is a "facility of many functions," some of which are as follows:

a. Monitoring RF transmissions from NASA vehicles.

b. Launch data collection for and retransmission to data users.

c. Scientific, general-purpose, and business computing for NASA and NASA contractor operations at KSC.

d. Instrumentation engineering and development to meet special data requirements and to evaluate state-of-the-art advances in instrumentation equipment.

e. Instrument certification repair and calibration for all NASA and NASA contractor operations at KSC.

f. Central station for timing correlation and distribution at KSC.

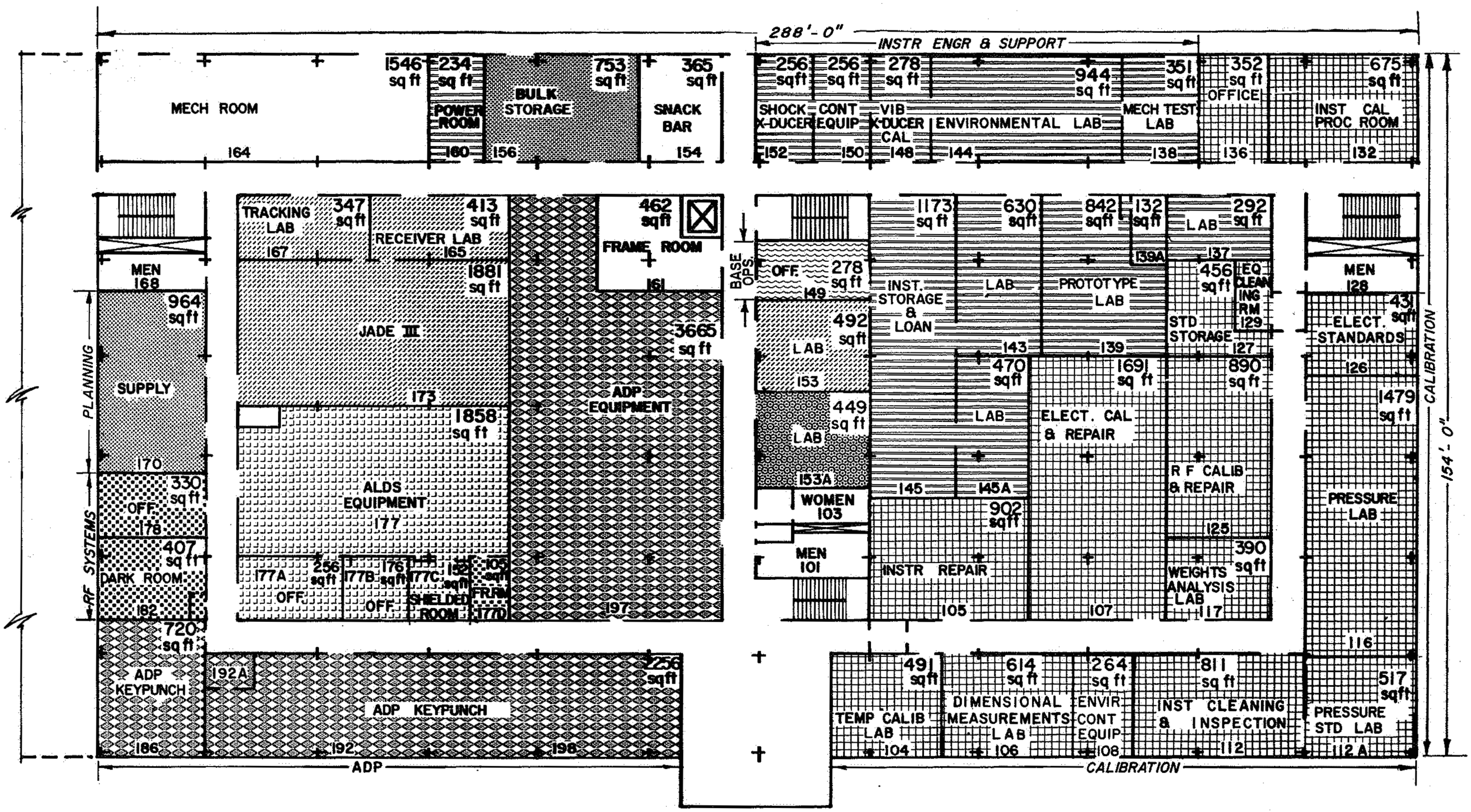
g. Central offices for KSC instrumentation managers and engineers.

5.1.1. First Floor of the CIF

The first floor of the CIF is used for the following activities:

a. Instrumentation engineering activities on this floor are conducted in shops and laboratories for instrument maintenance, repair, testing, calibration, fabrication, assembly, and checkout of instruments. The laboratories and shops are the center of KSC instrumentation systems support at KSC. The services of this area are made available to service instrumentation of other NASA Centers and NASA contractors who have operations at KSC and Cape Kennedy.

Figure 12 - Central Instrumentation Facility



10 5 0 10 20 30
SCALE IN FEET

Figure 13 - CIF, First Floor

MAR. 16, 1963
REV. SEPT. 10, 1965

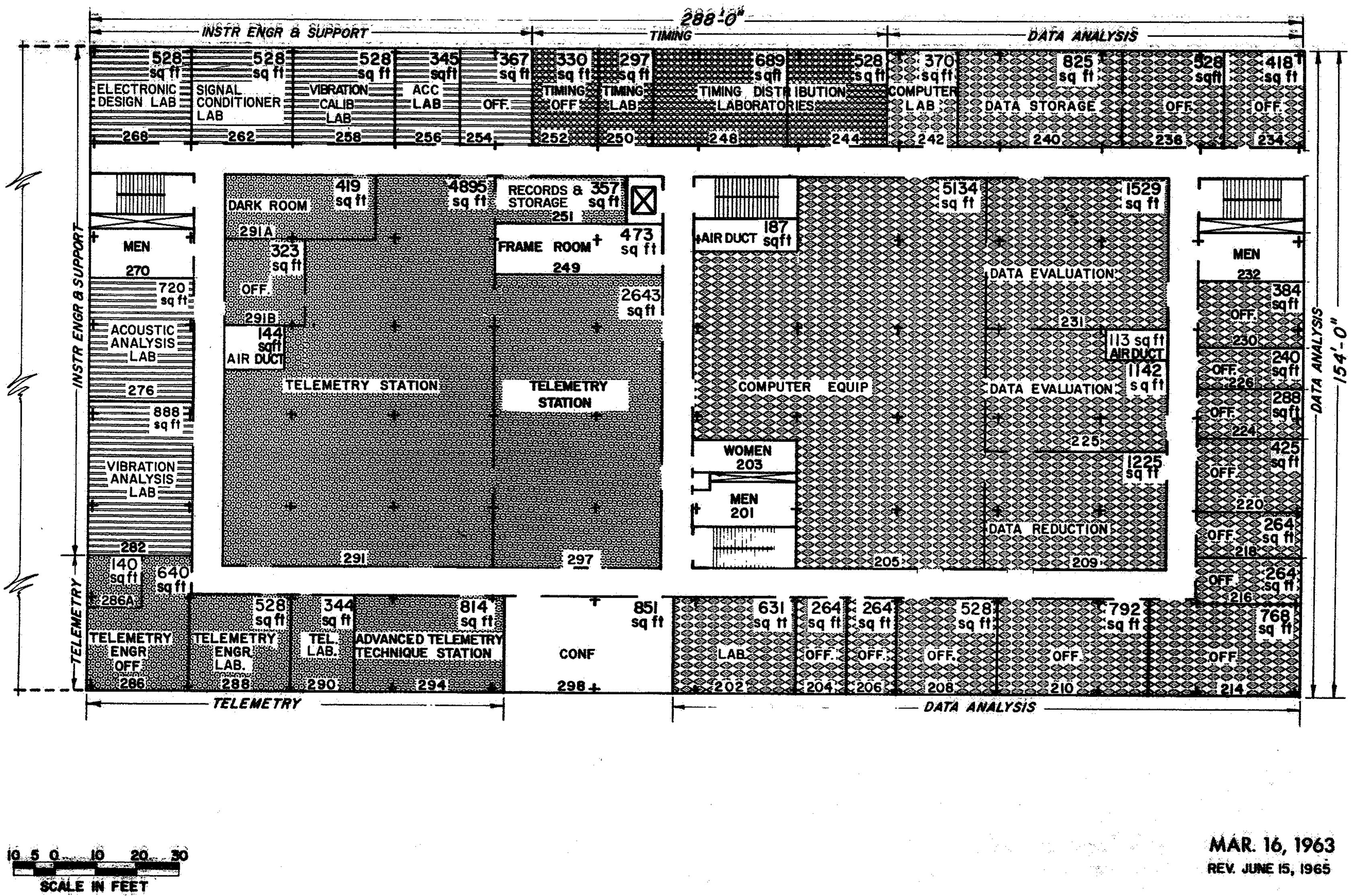


Figure 14 - CIF, Second Floor

SECTION 6

RELIABILITY AND QUALITY ASSURANCE PROGRAM FOR LAUNCH INSTRUMENTATION

6.1. Introduction

The NASA Apollo Program requires delivery of only small numbers of each system, operates under tight schedules, and requires high reliability in the first item of each system as well as in later items. This makes it imperative that a thoroughly disciplined, systematic approach to reliability be adopted.

The reliability and quality assurance provisions for Launch Instrumentation equipment is established in the KSC Apollo Reliability and Quality Assurance Plan, K-AMP-5.

The KSC Reliability Assurance Policy is to use all proven reliability engineering and operational techniques to ensure mission success and to minimize prelaunch delays, failures, scrubs, and recycles on Saturn/Apollo mission-essential equipment at KSC.

The KSC Quality Assurance Policy is to use all proven quality assurance techniques to ensure that both in-house and contractor-supplied, mission-essential hardware is produced, installed, operated, and maintained to a degree of quality that will assure design intent and mission success.

6.2. Reliability Assurance Program

Reliability implementation at KSC is decentralized; implementation is planned and performed by reliability groups in the various KSC operational and design organizations.

The KSC Apollo Reliability and Quality Assurance Office is the policy-making body for KSC Apollo Program Management on all R&QA matters. This office establishes, defines, administers, and coordinates KSC Apollo Program R&QA policy and management. The office also interprets and administers NASA Headquarters policy, and assures compatibility among KSC organizations concerned with reliability and quality assurance.

Primary responsibilities of Launch Instrumentation Reliability are to:

a. Ensure that adequate, consistent reliability requirements are invoked in Instrumentation Program contracts and procurements; and participate in the selection of suitable contractors. Coordinate with the Quality Assurance and Safety Office to ensure that adequate quality requirements are invoked in contracts for technical equipment and services being procured.

b. Develop and implement means to ensure that Apollo Program contractors and subcontractors comply with reliability requirements. Monitor performance through implementation of Reliability Program Surveys and Reviews.

c. Ensure that instrumentation equipment designs consider reliability, quality, availability, ease of maintenance and operation, and human factors.

d. Ensure that reliability testing is included in the design of instrumentation equipment when required. Audit the tests and test methods to ensure proper implementation of the test program.

The Launch Instrumentation reliability requirements are consistent with those established in NPC 250-1, Reliability Program Provisions for Space System Contractors.

a. Reliability Engineering. Reliability Engineering is considered an integral part of all phases of the design and development process for Launch Instrumentation. The basic elements of the Reliability Engineering Program include, but are not limited to:

(1) Design Specification

(2) Reliability prediction and estimation

(3) Failure mode, effect, and criticality analysis

(4) Maintainability and elimination of human-induced failures

(5) Design review program

(6) Failure reporting and correction

(7) Standardization of design practices

(8) Parts and materials program

(9) Equipment Logs

b. Reliability Testing and Evaluation. The Reliability Testing and Evaluation Program, when required, will be directed toward evaluating system reliability throughout the design and development process. This will be done by an integrated test program conducted in parallel with a reliability assessment program which will incorporate the results of these tests.

The Reliability Program Plan submitted by the contractor in accordance with paragraph 2.2 of NPC 250.1, and agreed to by NASA, serves as the master planning and control document for the reliability program.

6.3. Quality Assurance Program

Quality Assurance implementation at KSC is centralized; implementation is planned and performed under the Director, Quality Assurance and Safety. The chief goal of the Quality Assurance Program is to ensure that the procured equipment is not degraded in the manufacturing and handling processes. Quality assurance functions are performed in accordance with NASA Publications, NPC 200-1A, 200-2, 200-3, 200-4 MSFC Specifications, MIL-Specifications, MIL-Handbooks, Contractor in-house Specifications or applicable portions or combinations thereof.

a. Government Inspection Agencies. Quality Assurance functions for Government Inspection Agencies are performed in accordance with NASA Quality Publication NPC 200-1A or applicable portions thereof.

b. Suppliers. Inspection system provisions for suppliers of space materials, parts, and components are in accordance with NASA Quaility Publication NPC 200-3 or applicable portions thereof.

c. Quality Assurance Program Plan. The Quality Assurance Program Plan submitted by the contractor in accordance with NPC 200-2 and agreed to by NASA is the planning and controlling document for the contractor's Quality Assurance Program.

SECTION 7

MANAGEMENT PLAN

The project and systems management responsibility for Launch Instrumentation at KSC is shown in the organization chart (Figure 18) for the KSC Director, Information Systems.

The KSC Director, Information Systems is responsible for supervision and direction of Center instrumentation activities (other than instrumentation on board the flight vehicle and checkout equipment related directly thereto) including radio frequency and telemetry, data acquisition and systems analysis, measurements systems, and instrumentation planning and coordination; and participates fully in the formulation and establishment of policies and plans for mission accomplishment.

The Chief of the Data Systems Division is responsible for maintaining cognizance of the instrumentation systems used to obtain test data on space vehicle launches; performing analysis functions pertaining to all instrumentation systems used for space vehicle flights; fulfilling all requirements that necessitate general-purpose scientific computer application at KSC; and is responsible for planning and executing test data handling at KSC for NASA and NASA contractor organizations at AFETR and KSC. These responsibilities encompass requirements originating in support of stage contractors as well as other NASA Centers.

The Chief of the Measurements Systems Division is responsible for performing instrumentation systems design and development for facilities and geophysical measurements systems, operating laboratory and testing facilities, providing facilities and geophysical measuring systems, and is responsible for timing and countdown distribution systems at KSC.

The Chief of the Telemetric Systems Division is responsible for ensuring the provision and effective operation of telemetry ground systems, advanced RF systems, prototype tracking systems, and attendant equipment in support of all KSC missions and other NASA requirements at Cape Kennedy and KSC.

The KSC organization (approved April 27, 1966) is shown in Figure 19. This Center's reorganization is being extended to division and branch levels in each directorate; however, pending completion of the reorganization, Figure 18 is the current official organization for Information Systems (approved October 12, 1965).

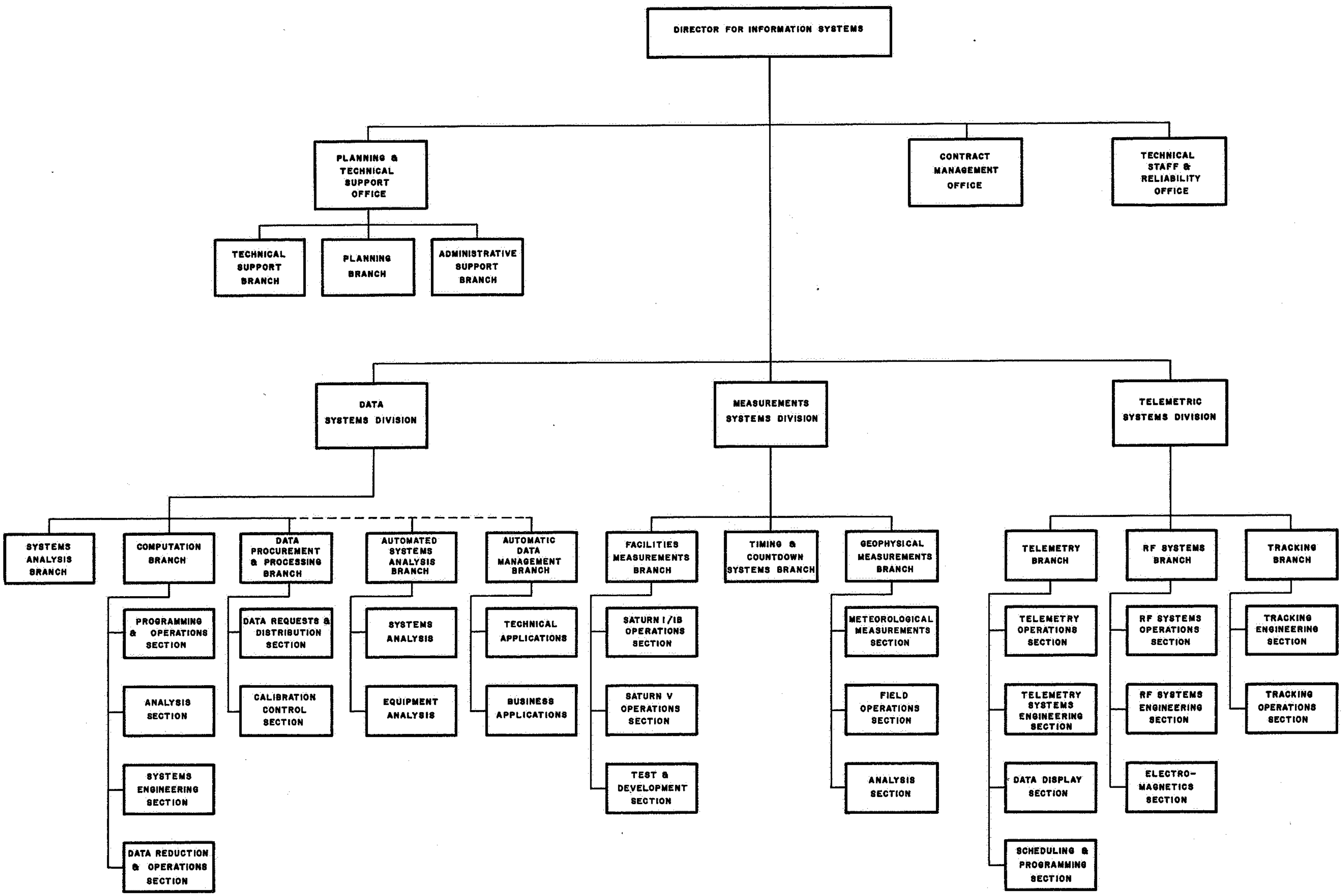


Figure 18 - Information Systems Organization Chart

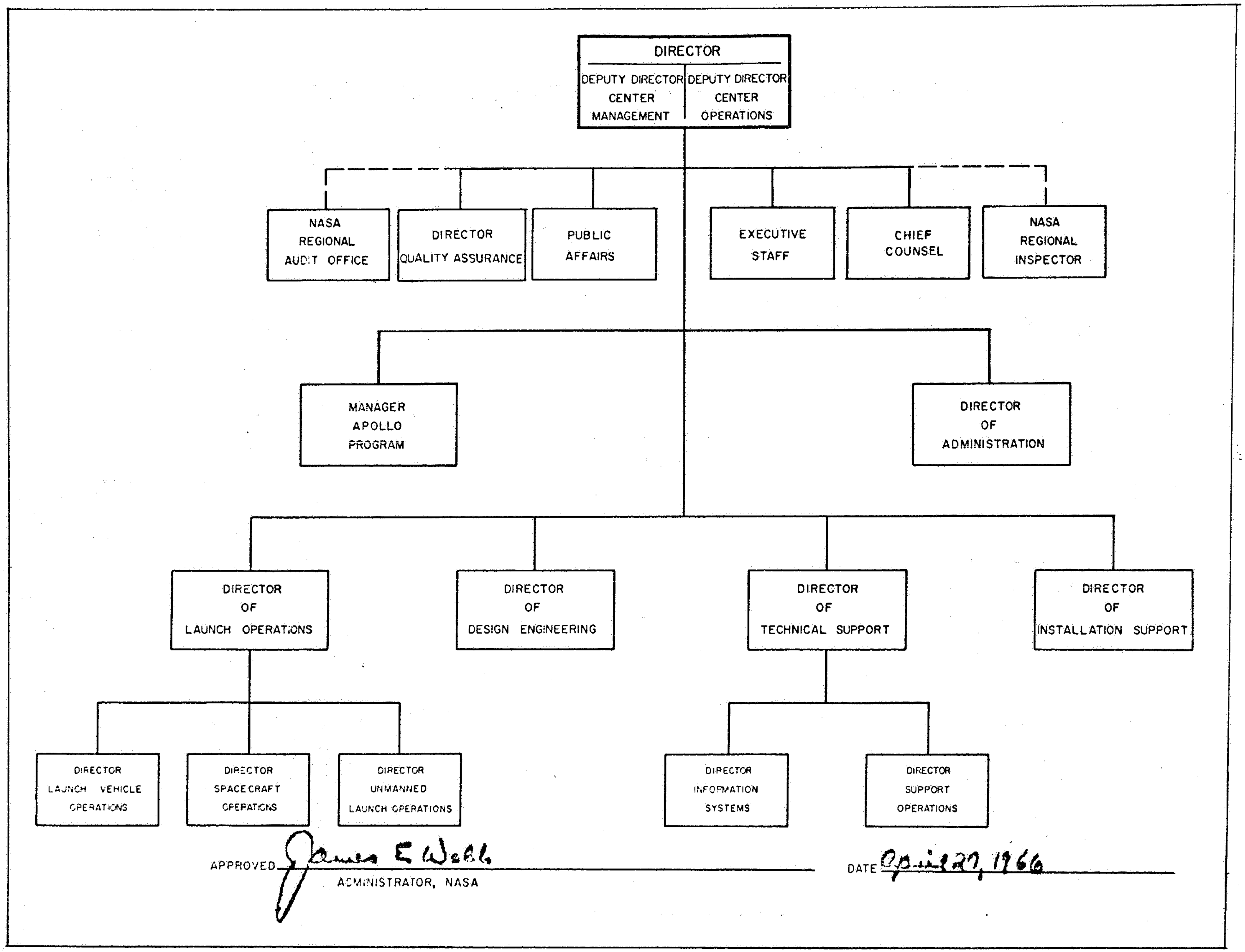


Figure 19 - KSC Organization Chart

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SECTION 8

MANAGEMENT REPORTING AND DOCUMENTATION

8.1. Management Reporting

KSC submits a Quarterly Technical Progress Report to NASA Headquarters to summarize technical progress and significant milestones accomplished during the reporting period. This report incorporates a detailed section on Launch Instrumentation.

8.2. Documentation

The reports published at KSC for launch instrumentation in the Saturn program are as follows:

a. Consolidated Instrumentation Plan, Part IIa of the Firing Test Report. Published for each vehicle about 60 days before launch and updated as required.

b. Instrumentation Operations Analysis, Part IIb of the Firing Test Report. Published for each vehicle about 30 days after the launch.

c. Instrumentation plans for each block or group of vehicles, with more general long-range planning information than the consolidated instrumentation plans. Published for each distinct group of vehicles one-half to three years before the first vehicle (i.e., when sufficient information can be obtained to prepare the report) and updated as required.

d. Consolidated Data Summary. A summary of instrumentation performance published 14 days after launch.

e. Vehicle Measurements Programs. Published prior to the launch of each vehicle. Updated continuously until the actual flown measurements are reflected.

f. Ground and Environmental Measurements Program. Published prior to the launch of each vehicle. Updated continuously until the actual launch day measurements are reflected.

g. Data Support Plan. Published prior to the launch of each vehicle and updated continuously until launch.

h. Various technical reports are published if significant information is to be disseminated.

i. PERT/TIME Level "C" Networks. Published for Complexes 37 and 39 and updated bi-weekly. These networks represent the site activities plans of the Director, Information Systems.

j. Requirements Document (RD). Outlines in specific detail the requirements placed upon KSC by internal elements of KSC, other NASA Centers, and DOD to support a program, mission or test.

k. Support Directive (SD). This document is the KSC in-house response to the RD. It is in narrative form that generally follows the National Range Division's Operations Directive in format. Responding to requirements contained in the Program Support Requirements Document, all items are extracted from the SD and forwarded to the Operations Support Requirements Office as the KSC Program Support Plan input.

SECTION 9

PROCUREMENT ARRANGEMENTS

Launch instrumentation procurement philosophy differs for the various instrumentation systems, ranging from large general-purpose computer systems, which are procured as a system, to telemetry station equipment which is procured by subsystems.

Computing equipment is frequently rented pending determination of its useful operational life and then purchased if determined to be in the best interest of the Government.

Most of the instrumentation equipment is procured through subsystem contracts, which are for off-the-shelf stocks. Specialized RF and telemetry equipment, such as the Data Core, is built to order. Procurement of equipment is conducted through the KSC procurement organization.

The instrumentation facilities, such as the CIF, are obtained through KSC Facilities Division and the Corps of Engineers.

SECTION 10

SCHEDULES

Current scheduling information at launch instrumentation systems is contained in the Manned Space Flight Schedules, Volume VII, Book 1 and Volume VIII, published monthly by KSC.

SECTION 11

FUNDING

The Launch Instrumentation Systems Funding charts in the Appendix show planned R&D and C of F obligations, history, and one-year projections for the KSC Director, Information Systems. Table 2 shows funding for launch instrumentation systems. A proposed addition to the CIF is currently planned for FY-68.

TABLE 2. FUNDING SUMMARY FOR LAUNCH INSTRUMENTATION

	FY-64		FY-65		FY-66		FY-67 *		FY-68 *		FY-69 *		FY-70	
	C of F	R&D	C of F	R&D	C of F	R&D	C of F	R&D	C of F	R&D	C of F	R&D	C of F	R&D
COMPUTER EQUIPMENT	9, 300K					883K		1, 337K		3, 880K		2, 016K		
INSTRUMENT CALIBRATION		802K		881K				1, 206K		1, 400K		1, 450K		
TIMING & COUNTDOWN		296K		241K		750K								
GEOPHYSICAL MEASUREMENTS	265K	130K	812K	875K		765K		437K		1, 075K		1, 115K		
FACILITY MEASUREMENTS	2, 582K	549K	4, 938K	140K		732K		1, 232K		1, 876K		1, 350K		
TELEMETRY	5, 204K	509K		368K		2, 144K		1, 399K		1, 802K		1, 406K		
REAL-TIME DATA DISPLAY	6, 015K	138K		43K		226K		-0-		180K		555K		
RF SYSTEMS	1, 500K	449K		927K		428K		832K		1, 088K		1, 025K		
TRACKING	3, 405K	262K		385K		171K		655K		2, 368K		2, 128K		
PLANNING						102K		59K		179K		251K		
ANTENNAS	2, 700K													
DATA HANDLING										37K				
EMI						78K		145K		645K		889K		
OPERATIONS & MAINTENANCE		4, 467K		2, 356K		2, 814K		8, 352K		14, 179K		13, 596K		
SPECIAL INSTRUMENTATION						22K		114K		291K				
CIF CONST. & UTILITIES	7, 049K													
TOTAL	** 38, 020K	7, 602K	** 5, 750K	6, 216K	-0-	9, 115K	-0-	15, 768K	6, 000K	29, 000K	-0-	25, 781K	-0-	21, 000K

* BUDGET FIGURES ARE AS SUBMITTED IN CURRENT POP (66-3) FOR SUPPORT OF APOLLO PROGRAM THROUGH 1970. THIS DOES NOT INCLUDE FUNDING TO SUPPORT THE ANTICIPATED APOLLO APPLICATIONS PROGRAM (AAP).

** FY 1964 AND FY1965 C OF F PROJECT NUMBERS 7646 (CIF) AND 7620 (LC-39).

SECTION 12

MANPOWER

12.1. Civil Service Manpower

Projections for Launch Instrumentation manpower are shown in two parts in Table 3. The Civil Service manpower includes project and system management, as well as contract monitoring. It is to be noted that Civil Service manpower buildup has been limited to present strength, although additional functions have been added. Planned Civil Service levels are shown for comparison.

12.2. Contractor Support

The contractor support schedule in Table 3 shows the Federal Electric Company personnel in the Instrumentation Operation and Maintenance contract. This contract was modified in November 1964 to include computer support services. Projected contractor manpower has been increased in consideration of heavier contractor workload within existing activities and planned addition of new activities. The programming and operation of ADP business computing equipment is presently being performed by Computer Applications, Inc., and will continue as is until the expiration date of the FEC computer support contract. A combined proposal for all instrumentation services will then be offered on Invitations to Bid for a single contract.

Table 3. Manpower History

Civil Service Totals							
Year-End Fiscal	1964	1965	1966	1967	1968	1969	1970
Totals	187	221	239	249*	296*	296*	296*
Contractor Personnel Totals							
Year-End Fiscal	1964	1965	1966	1967	1968	1969	1970
Totals	58	162	381	602	1,060	1,000	1,000

*The numbers for year-end fiscal 1967 and on are projections.

SECTION 13

COORDINATED OPERATIONS PLAN

The Information Systems Directorate is represented in the Launch Countdown Operations organization by an Information Systems Instrumentation Controller, who is located in the LCC and speaks for the status of all INS systems throughout launch countdown. The Launch Countdown Operations organization for SAT IB/V is depicted in Figure 20 (refer to KSC Document 170-39-0008, dated August 27, 1965).

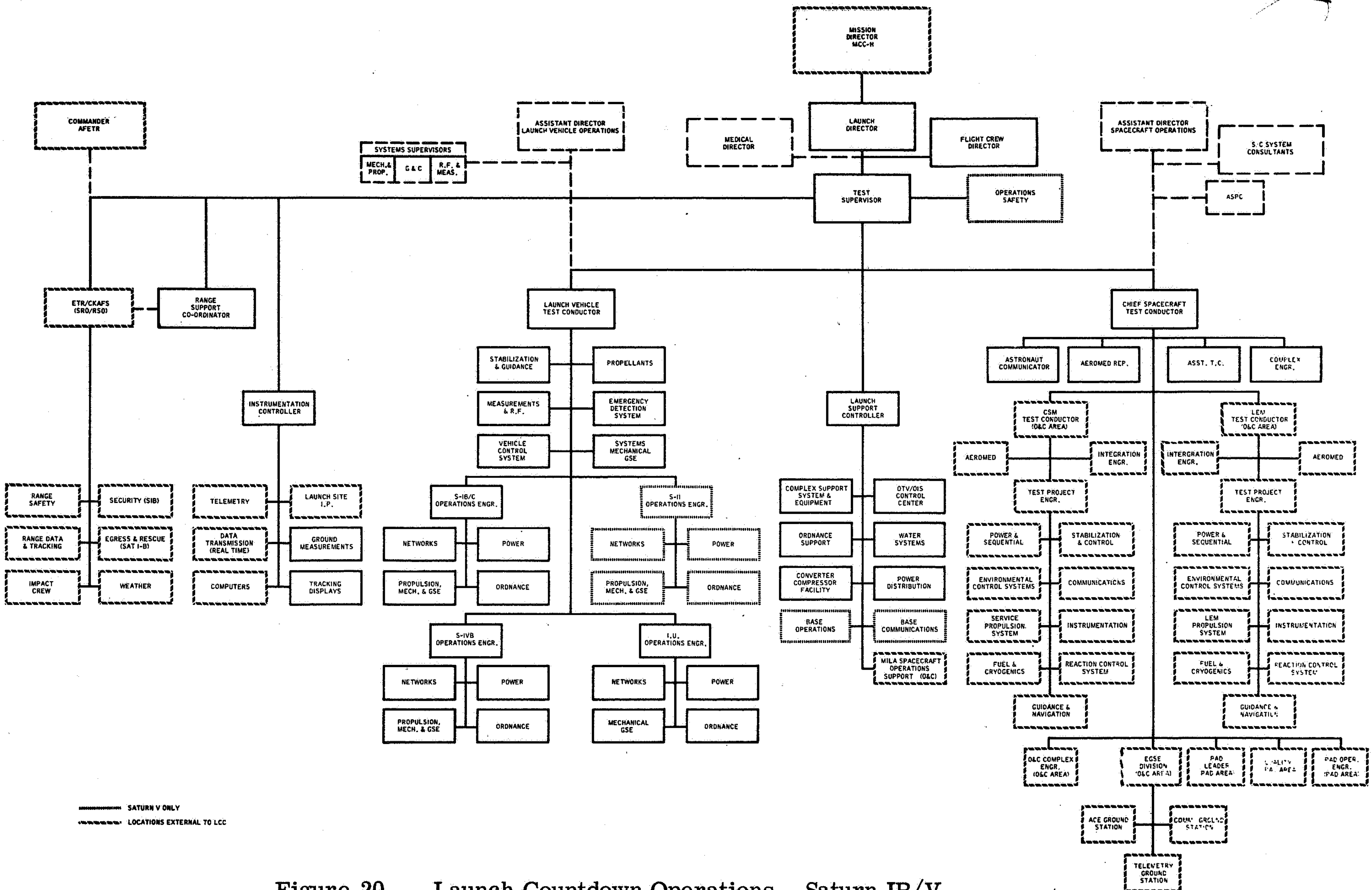

Figure 20 - Launch Countdown Operations - Saturn IB/V